Engineering News

VOLUME 73 APRIL 29, 1915 NUMBER 17

The Panama-California Exposition

The Panama-California Exposition now being held at San Diego, Calif., is not organized on an international basis or to rival the larger exposition at San Francisco. Its purpose is to promote the settlement and development of the Southwest, and its exhibits relate particularly to the products and resources of that territory. For instance, the machinery exhibit is confined to power, irrigating and agricultural machinery, which is shown in operation. The exposition was opened on Jan. 1 and will close on Dec. 31. It is managed by a corporation. Frank P. Allen, Jr., is Director of Works and Chief Engineer, and he prepared the general plan and design of the exposition. G. R. Taylor and T. B. Hunter were assistant engineers. A stock company was formed, to which the people of San Diego subscribed $1,150,000. The city voted two bond issues of $1,000,000 and of $850,000; as the site is in a large city park, the money was voted as for "park purposes." California and other Western states made appropriations for buildings and exhibits, and these, with the cost of various exhibits by individuals and corporations, brought the total cost to about $8,000,000.

The site has an area of some 620 acres in a park of 1400 acres, but much of this in cañons and hillsides, and the exposition proper covers a practically level mesa, or elevated plain, of about 250 acres. The ten main buildings are as follows: 1, Botanical; 2, Commerce and Industries; 3, Fine Arts; 4, Food Products; 5, Foreign Arts; 6, Home Economy; 7, Indian Arts; 8, Science and Education; 9, Tractors; 10, Varied Industries. These contain exhibit space of about 500,000 sq.ft. In addition, there are seven state buildings and five for California counties. The California State Building and the Fine Arts Building were designed by Cram, Goodhue & Ferguson, of New York. All the other buildings of the exhibition company, and those of the several counties, were designed by Mr. Allen. The architectural style of the exhibition is Spanish-Colonial and is more ornate than in most buildings of this character, as will be seen by the accompanying illustrations. One group of buildings, at the end of a bridge (Fig. 1), is of reinforced-concrete construction and will form a permanent museum. The Botanical Building is also permanent. All the others are of

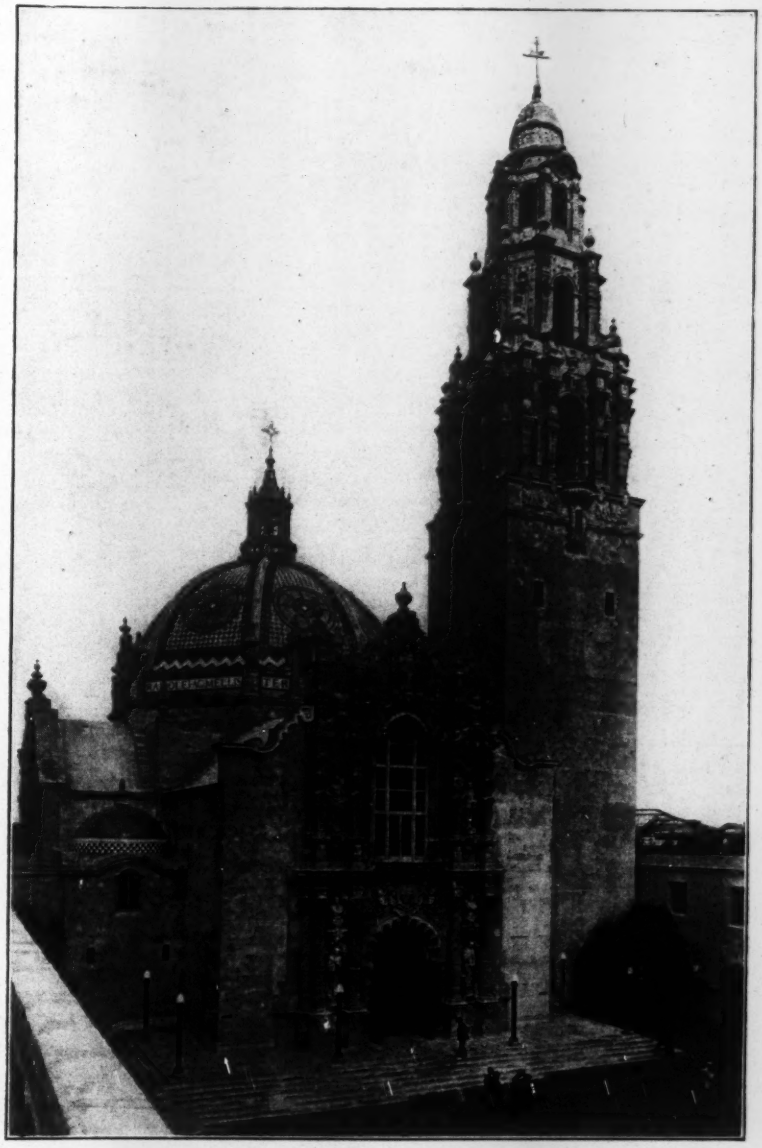


FIG. 1. THE CALIFORNIA BUILDING AT THE PANAMA-CALIFORNIA EXPOSITION, SAN DIEGO, CAL.
(This is part of a permanent building to be used as a museum)

wood and plaster construction, with staff decoration.

There are separate storm and sanitary sewers. The storm sewers are discharged at frequent intervals into the many small cañons surrounding the mesa upon which the exhibition is built, thus avoiding large pipe sizes. The sanitary sewers are connected to the city system through two outfalls on opposite sides of the grounds. Concrete pipe was used on both systems. The water-supply is obtained from the city water system through two connections (16-in. and 12-in.) and is distributed through the grounds by means of 6.2 miles of cast-iron mains, to which are attached 30.6 miles of irrigating lines, varying from 2 to 4 in. in diameter.

The principal streets and avenues are paved with a 1-in. asphaltic wearing surface on a 2½-in. bitulithic base. This pavement is laid directly on the ground, without concrete foundation, and is giving good service. It stood up very well under the heavy hauling of materials and exhibits. Electric current is purchased from the San Diego Consolidated Gas & Electric Co., which delivers it at a sub-station at the edge of the grounds. The exhibition company distributes the current throughout the grounds for its own uses, as well as for the uses of concessionaires and exhibitors. Electric, telephone and fire-alarm wires are carried underground in conduits, no pole lines being used on the grounds.

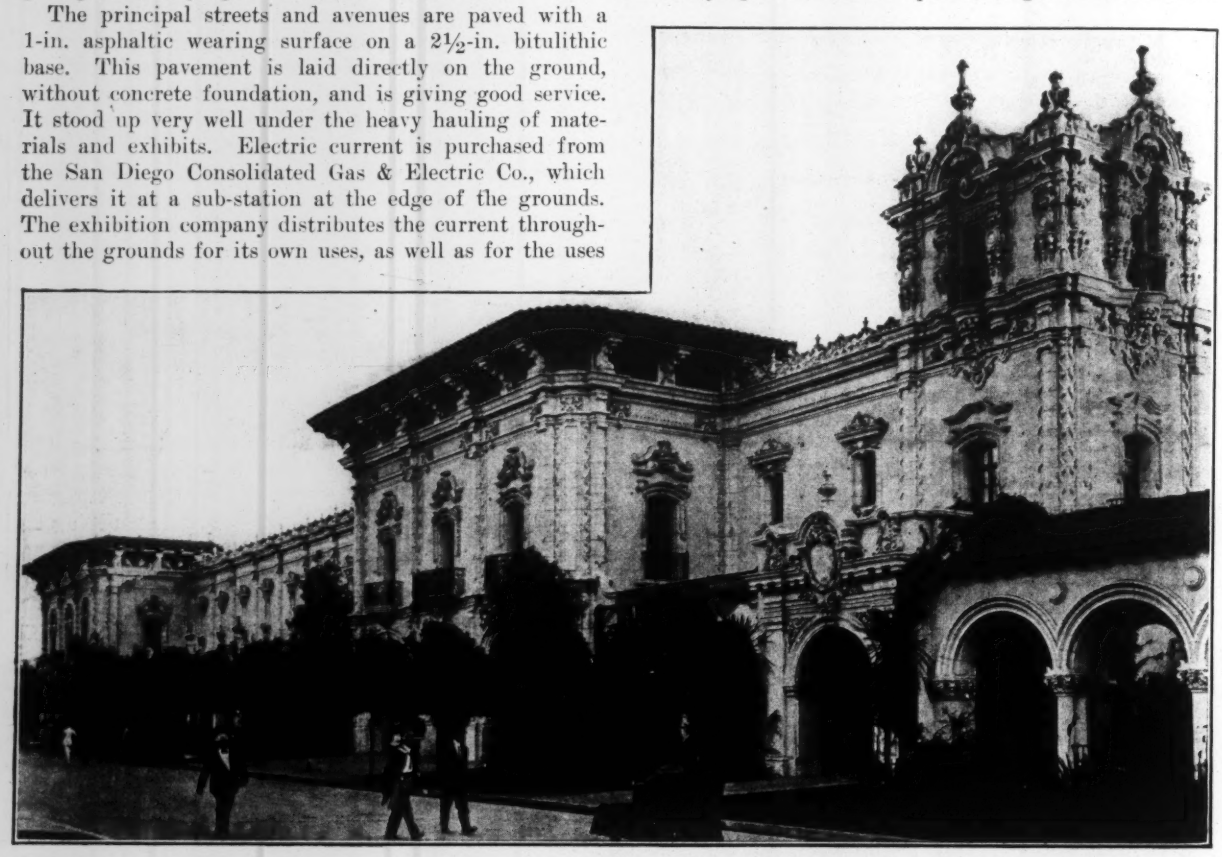


FIG. 2. COMMERCE AND INDUSTRIES BUILDING AT THE PANAMA-CALIFORNIA EXPOSITION, SAN DIEGO, CAL.

The bridge, permanent buildings, street and road work, water and drainage systems, and all planting and landscape work constitute permanent improvements to the city park. Approximately 60 per cent. of the money expended in construction will be of permanent benefit to the park.

A Motor Ship of 450 hp. equipped with reversible propeller blades to avoid reversing the engine has been built by the Nederlandsche Fabriek, of Amsterdam, Holland. As described in "The Engineer," of Mar. 26, this motor ship is an oil-tank vessel 185 ft. long and 36½ ft. beam, with a capacity of 835 tons of oil. The reversing of the propeller is effected by rotating the three blades around a central axis, hence the pitch of the propeller can be changed and it can be thrown into neutral position as well as into fore-and-aft position, when desired.

Herbert Spencer, Engineer

BY ERNEST EDGAR THUM*

The engineer is often startled to find references in unexpected places linking the names of famous men with the development or practice of his art. A notable case appears in the "Autobiography of Herbert Spencer," the great philosopher. His readable and lucid style has given him perhaps the widest audience and influence of any modern philosophical writer. His work in pedagogy is not so well known; but to his efforts, more than to those of any other man, the engineer of today owes the privilege of studying science on an equal footing with the humanities, which were once the sole content of the university curriculum.

Herbert Spencer commenced engineering work in 1837 on the London & Birmingham Ry. under Robert Stephenson. Although he came from a family of unusually capable and successful educators, his education would be called very limited in a youth of today—a fair amount of mathematics (that is to say, Euclid) and a little of the languages, but no history, general literature or science. His self-confessed inability to profit by the usual mechanical rote-learning of that day had prevented his acquiring much from the subjects he had been taught. He was the typical "idle boy," with his lessons never learned—always dreaming of birds and beetles and fishes and rocks and the great outdoors.

His powerful and original mind, however, brought him

*236 North Jefferson St., Bay City, Mich.

success in the profession during the nine years that he followed it. Like John Ericsson, he felt that if he had had any special training "he would have acquired such a belief in authorities that he would never have been able to develop originality."

The theory underlying the most elementary design of structures was not then generally known or accessible, for we read from one of his letters:

I have been occupying my leisure lately in investigating transverse strength in all its forms. Several theories have suggested themselves, but I have not succeeded in coming to any satisfactory issue. I made experiments on trussed beams; the results, however, have quite disconcerted me, and appear, as far as I can see, to throw my theory to the winds.

At another time he writes of happenings familiar to every constructor:

I am engaged in superintending the pulling down and re-erection of a large bridge under the inclined plane at Bromsgrove. The time allowed was so small that there was no possibility of designing fit girders and having them cast. Such girders as had been designed for other purposes and could be obtained forthwith were consequently used. These were, however, too short to span the width of the road obliquely; and the result was that a framework, partly of these girders and partly of strong timber balks, had to be made. I was a little nervous about it, but it proved strong enough.

Toward the end of his engineering career he was employed by one William B. Prichard to locate what would now be called "wildcat" railroads. Later he had charge of Prichard's office, at £24 per week, and handled the location of several short lines, aggregating about 150 miles in length. Of this period he writes:

The rise of the railway mania dates back to the autumn of 1844, after the profitableness of railway investments and the advantages of railway communication had been for several years growing conspicuous. Ten years' teaching had made landowners anxious to profit by that raised value of land which proximity gave. Some towns, too, became eager for that which they had previously rejected. Meanwhile there had been yearly increasing the classes of contractors, engineers and lawyers professionally interested in railway enterprises and ready to coöperate in getting up new schemes. There grew up considerable classes of wealthy contractors, and of rich engineers accustomed to coöperate with them; it became the habit for these to join in getting up schemes, forming companies and practically appointing boards—a policy in all ways beneficial to themselves. It needed but to take a map of Great Britain and look out for a comparatively blank space where there were towns of some size; run a pencil mark through a number of them; gather together some known local names, headed, if possible, by one with a title; issuing flaming advertisements; and people rushed in to take shares.

During these last months the railway excitement had been rising and had spread to all classes, their only object being to get their shares to a good premium and then sell out. Naturally, the bubble burst. Spencer felt the pinch together with multitudes of others, and he found the mar-

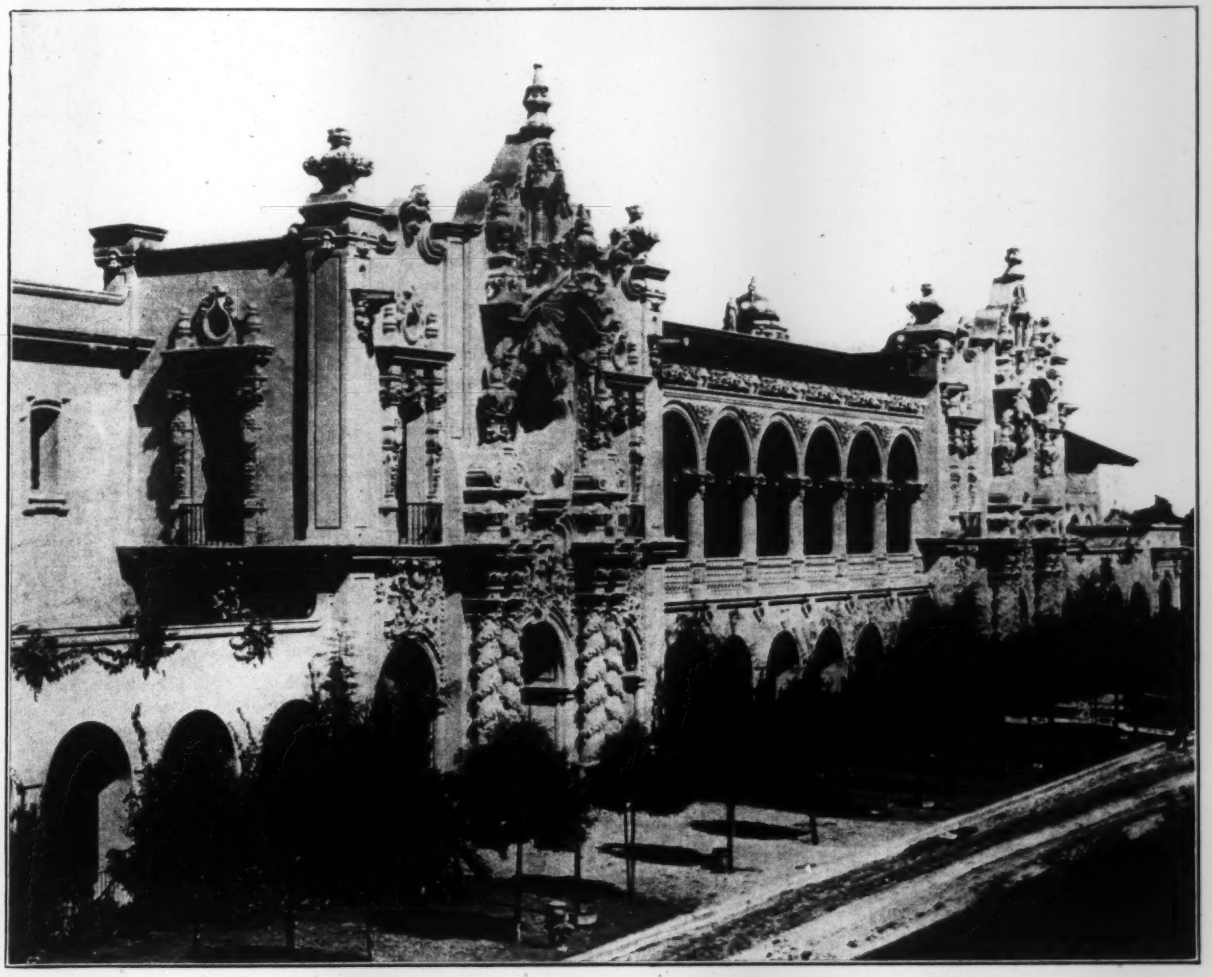


FIG. 3. VARIED INDUSTRIES BUILDING AT THE PANAMA-CALIFORNIA EXPOSITION, SAN DIEGO, CAL.

ket for engineering services so narrow that he finally abandoned the profession for literary work. Looking back on his engineering career he writes:

> Should I have made a good engineer had I continued in the profession? In some respects, yes; in other respects, no. In so far as inventiveness goes, I was adequately endowed, and might have succeeded; though it seems not improbable that inadequate regard for precedent might have entailed compromising mistakes. Another deficiency I recognize as one which might have prevented any great success—my lack of tact in dealing with men, especially superiors. In most occupations, and especially engineering, advancement depends rather on pleasing those in authority than on intrinsic fitness.

How many of us, looking back upon our past efforts and our relations with our fellow workers, recognize the truth of this remark! How many brainy, capable men have been distanced in the race toward success and pecuniary rewards by men of mediocre mental equipment! Opportunity, tact and brains will always be the prime essentials—the opportunity to show what a man can do, together with that tact or affability or assertiveness which ingratiates itself into the good graces of the powers that be, has been the foundation stone of many a flaming success in the engineering profession.

Center Bearing, Machinery and Gates, Congress St. Swing-bridge, Troy, N. Y.

The new Congress St. bridge over the Hudson River at Troy, N. Y., whose novel structural features were described by H. W. Hodge in ENGINEERING NEWS of Mar. 25, 1915, shows also some original design in its mechanical elements.

CENTER BEARING—The bridge is of pure center-bearing type. A 30-in. phosphor-bronze lenticular disk between hardened steel disks forms the bearing (Fig. 1). Eight balancing wheels on a 31½-ft. track keep the bridge steady while turning. When the bridge is in closed position, four wedges—under the ends of the two main cross-girders—hold it firm and take the live-load.

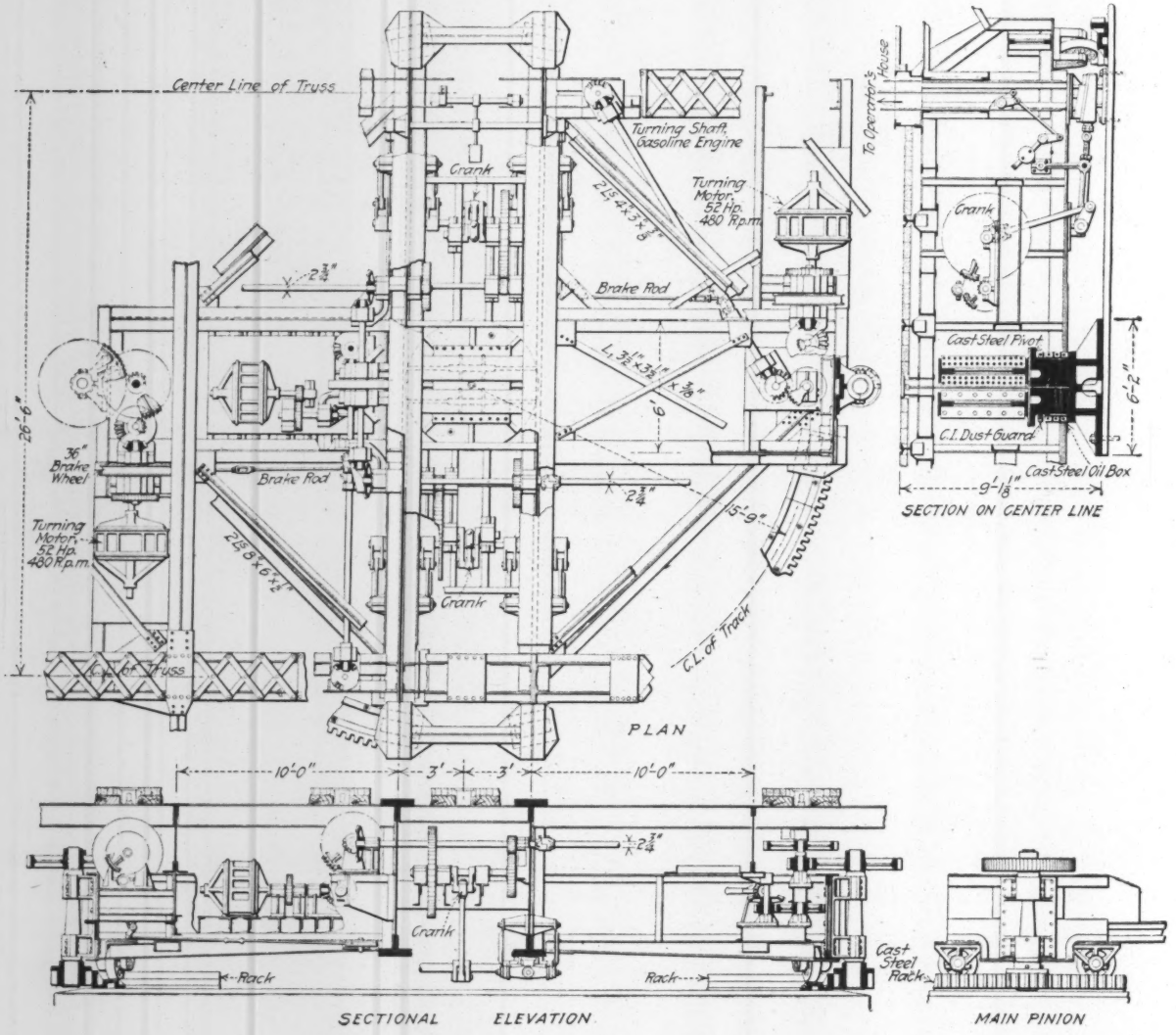


FIG. 1. CENTER BEARING AND TURNING MACHINERY

END BEARINGS—The usual two wedges at each end are provided (Fig. 2). But their operation is made positive by operating them with cranks with full throw to dead-center, in place of rocker arms. The same crank motion is used at the center wedges also. The designers consider that this modification of design makes the wedge-bear-

ings absolutely foolproof, as they cannot be overdriven. Further, the wedging motor may run always in the same direction, for drawing and driving, although it is capable of being reversed.

Rail-lifts for the ends of the street-car rails on the draw are operated from the wedging machinery. Such lifts are rare in highway bridge work, and the difficulties due to the pavement surrounding the rails complicate the problem. The hinged lift sections seat in socket castings on the fixed span. This is shown in Fig. 2, which also illustrates the spring-seated latch plate and the latch bar.

AUXILIARY GASOLINE AND HAND POWER—The War Department made an exceptional requirement as to the operating machinery. Because the electric power in Troy has been subject to interruption, it required the draw to be equipped with a gasoline power plant. This was placed in the operator's house over the middle of the span; Fig. 3 shows the arrangement of this house, and indicates the clutches for connecting the engine to the shafts. The controllers for the electric motors are shown.

HORN SIGNAL—Besides indicators for showing the operator the position of span and wedges, the house is equipped with a special large-size "Klaxon" horn. The instrument is mounted on a revolvable pipe standard, so that the sound can be thrown in any direction.

MACHINERY DETAILS—The bearings were one item of special design in the machinery. Fast-moving shafts are in babbitted bearings. The main pinion shafts rest in phosphor-bronze bushings. This provides for refitting when wear occurs. The ordinary shafts work in simple bored cast-iron boxes.

The collar boxes for bevel gears were in most instances detailed as one casting, so that their true right-angle adjustment is assured when once the shop work has been done properly.

GATES—Hand-operated safety gates of structural steel lattice, as in Fig. 4, are fitted on the fixed spans at either end of the draw. They are placed at the hip-vertical; that is, about 20 ft. back of the end.

The machinery was designed by the engineers who designed the foundations and structural work of the bridge, Boller, Hodge & Baird, of New York City.

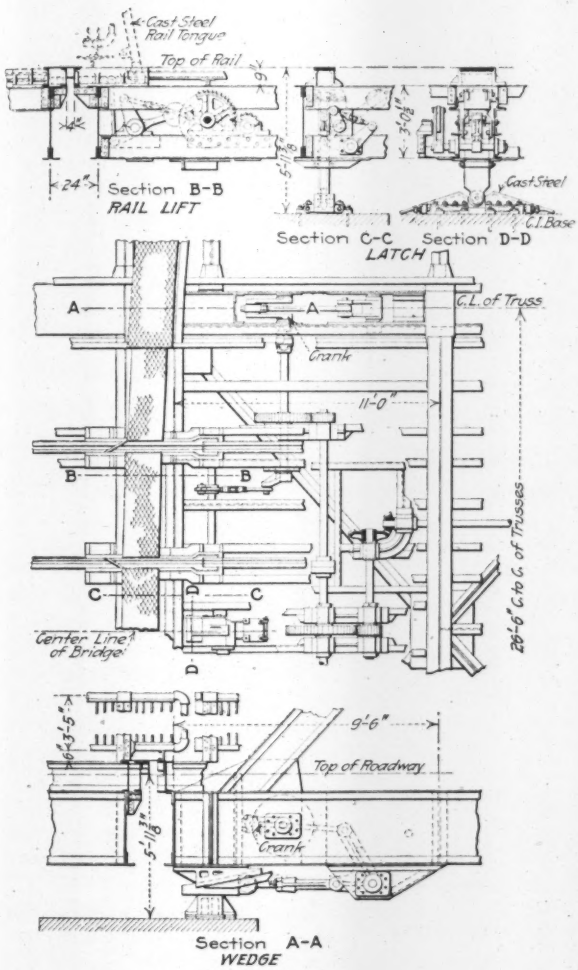


FIG. 2. END-LIFT WEDGES

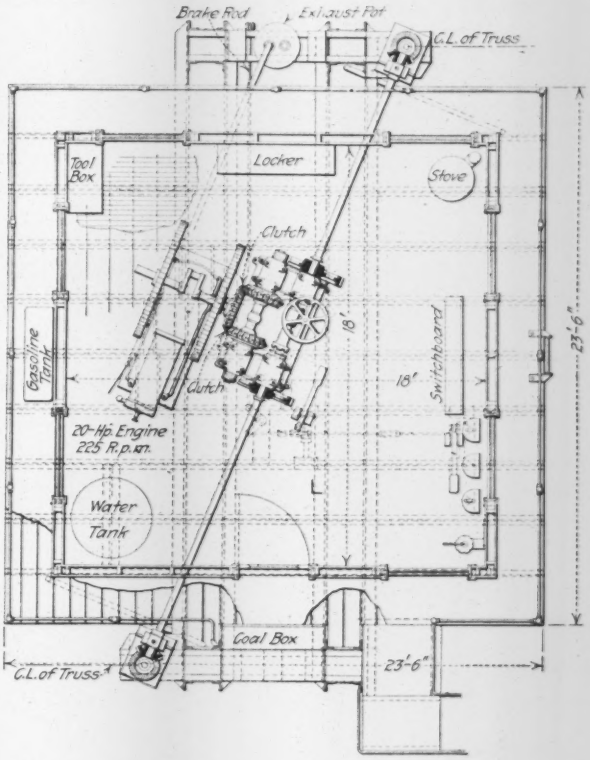


FIG. 3. OPERATOR'S HOUSE

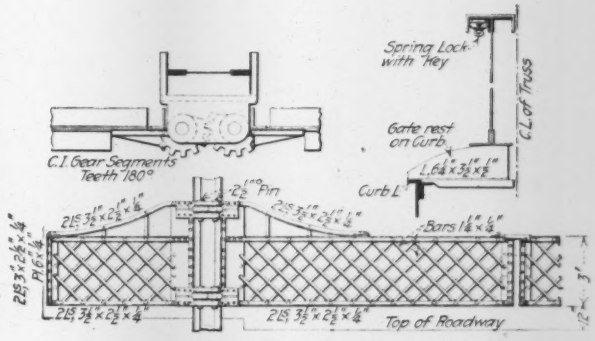


FIG. 4. SAFETY GATES

Contract Methods and Equipment for a Typical Ohio River Dam

By Karl H. Shriver*

SYNOPSIS—The Federal project for providing 9-ft. slackwater navigation for the Ohio River contemplates the construction of 53 locks and dams at a total cost of $47,000,000. Already 31 of these locks and dams have been completed or are under construction, and the remaining 22 will be started in the next two years. This article gives in detail the construction methods, the contractors' equipment, and the costs for a typical dam just completed.

Lock and dam No. 9, Ohio River, is located at New Cumberland, W. Va., about 55 miles below Pittsburgh. It is of the design common to the Ohio River improvement, a lock (110x600 ft. on the West Virginia side), a navigable pass (600 ft. wide), beartrap weirs (two, each 91 ft. wide), and a Chanoine weir section (224 ft. wide). The lock has the usual land wall and river wall, with two gate recesses and rolling steel gates on the shore side, and an upper and lower guide wall practically continuous with the land wall. All the lock walls are gravity sections, 5 ft. wide at the top, stepping down to a width of from 12 to 15 ft. at the bottom. The river wall, also a gravity section, is 12 ft. wide, except near the middle, where it is offset to a width of 24 ft. to form a foundation for a reinforced-concrete power house.

The navigable pass, shown in Fig. 3, is a concrete floor, provided with wooden wickets about 4 ft. wide fastened to horseboxes anchored into the concrete. The three piers of the beartrap weir are from 12 to 14 ft. wide, and carry between them the beartrap weir shown in detail in Fig. 2. The leaves of the beartrap weir are made up of 17 steel girders covered with buckle plates. The Chanoine weir is similar to the navigable pass, except that, in addition a steel trestle or service bridge is erected on the foundation above the crestline of the dam, and from this bridge the wickets are raised or lowered. All the walls and floors in the structure are on piles driven to rock, except the gate recesses, which are on sand and gravel. Wooden sheet piles above and along the side protect the foundations, and cribs and riprap protect them below from scour.

The main contract for the work was let to the National Contract Co. of Evansville, Ind., in the fall of 1910. The work was prosecuted through the succeeding three seasons. Construction was carried on inside a succession of coffer-dams (shown in Fig. 1), starting with the lock section, allowing the river meanwhile to pass through the undammed section.

As a control of the entire site, a cableway was first placed across the river 45 ft. below the crestline of the navigable pass. The cableway towers, each 135 ft. high, consist of two wooden bents of 13x13-in. timbers, well braced with 4x10-in. sticks and footing on concrete foundations placed before

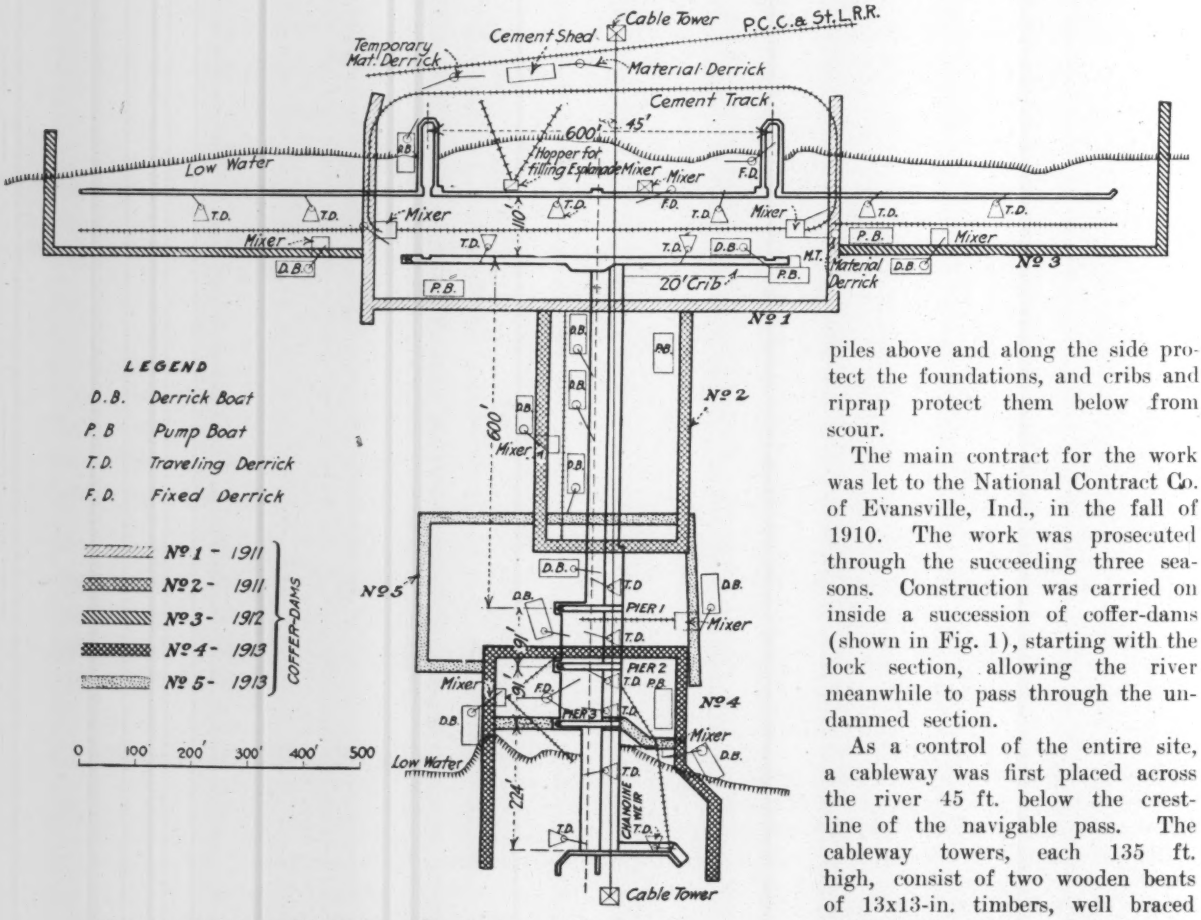


FIG. 1. GENERAL LAYOUT OF CONSTRUCTION PLANT ON OHIO RIVER LOCK AND DAM NO. 9

*U. S. Junior Engineer, 500 South Broadway, Wheeling, W. Va.

the towers were raised. On this cableway, all timber, stone, cement, and plant were transferred from the railroad siding to different parts of the work.

Lock Coffer-Dam

The first coffer-dam (Fig. 1) extended out from the West Virginia shore beyond the lock site, with a top level 16 ft. above low water. It was of the regular box type, 20 ft. wide, with 2-in. sheathing on both sides, braced by 6x6-in. and 6x8-in. outside wales spaced 5 ft. above each other and held together by rods spaced about 6 ft. center to center. Spreaders of 3x4-in. timbers 20 ft. long held the sides of the coffer-dam apart, and cross bracings of 2x10 stiffened the bents at the ends of the wales. It was filled with gravel and sand dredged from the lock site.

Excavation—While the coffer-dam was being built excavation was started from a dredge boat and several derrick boats, the latter being equipped with clamshell and orange-peel buckets. Very little hand excavation was necessary after the coffer-dam had been unwatered.

Cribs—Before the lower arm of the coffer-dam was closed in, an L-shaped section of the crib for the lower end of the river wall was built and sunk, being weighted down with heavy stone. This served as a foundation for pump boat No. 1, Fig. 1. After unwatering the coffer-dam, and after the sheetpiles on the outside of the lower end of the river wall had been driven, the other sections of the crib were built on the ground to their full height, and sunk by excavating inside the pockets with orange-peel buckets from traveling derricks.

Piledriving—In driving piles, sheetpiles were driven first around any section where round piles were required, so as to inclose the material to be compacted by the piledriving. At the beginning, both sheetpiles and round piles were driven from a derrick boat with swinging leads, but later stationary leads were set up. The average number of sheetpiles 25 ft. long, driven in an 8-hr. shift, was 12, and it varied between 6 and 18, depending upon the nature of the material and the elevation of the rock. The average number of round piles 30 ft. long, driven in 8 hours, was about 20.

Concrete—For the concreting of the lock, two concrete-mixing plants were placed, one at the upper and one at the lower end of the coffer, and were connected by a 3-ft. track. Fixed derricks on top of the coffer-dam, having 80-ft. booms, supplied them with sand, while cement was hauled from a cement-house on tracks laid on the top of the upper and lower coffer-dams. Concrete was delivered from the mixers by two travelers on each side of the concrete track, close enough to the wall to reach the forms.

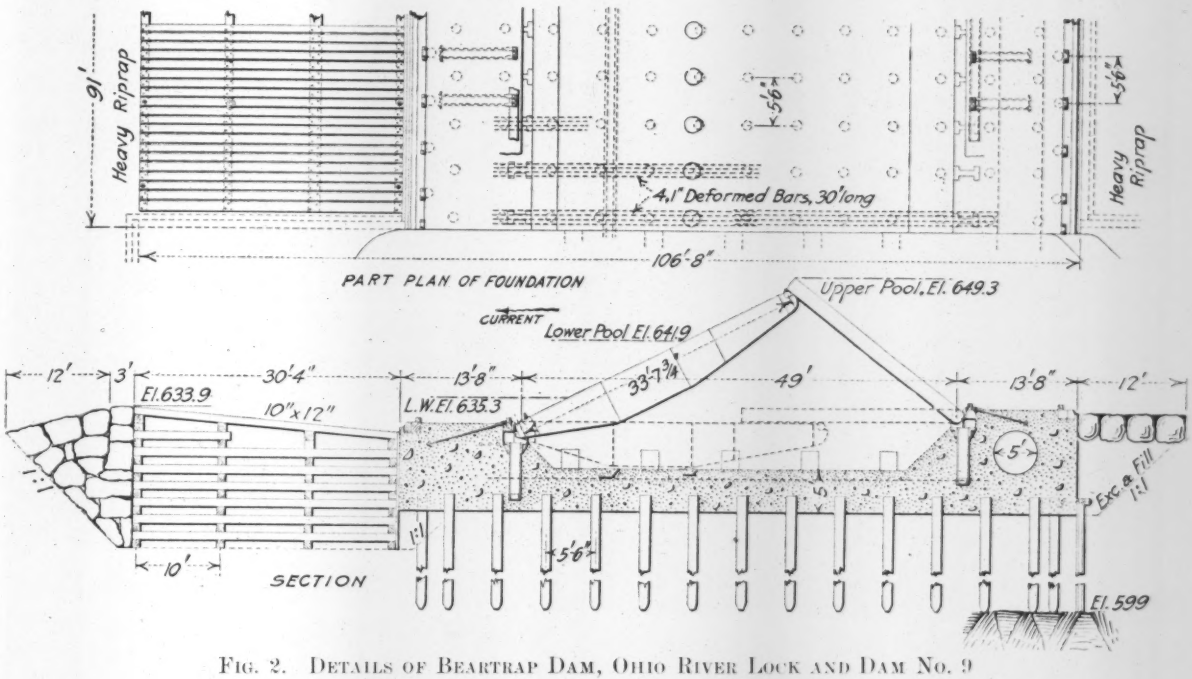


Fig. 2. Details of Beartrap Dam, Ohio River Lock and Dam No. 9

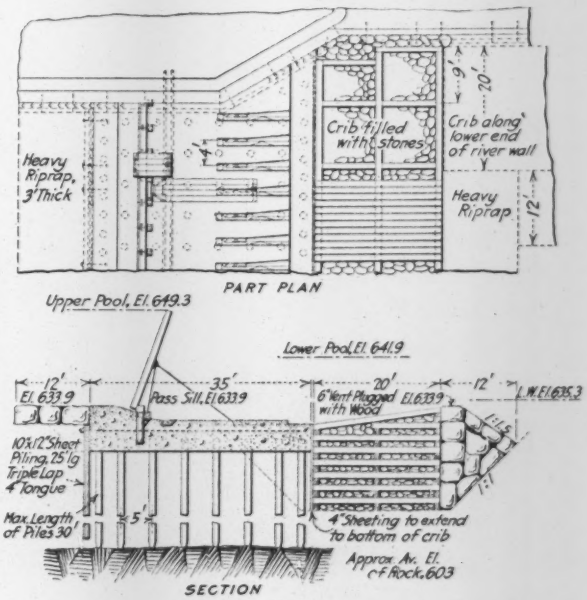


Fig. 3. Details of a Navigable Pass, Ohio River Lock and Dam No. 9

These were moved about as occasion demanded. The forms for the concrete walls were of the usual wooden waled type.

LOCK PAVING—The concrete paving of the locks is 18 in. thick and divided into blocks of 6x8 ft. Two 6-in. holes to relieve upward water pressure were provided in each block by leaving common sewer pipe as forms. Steel plates, well oiled, were used as forms for the blocks. Square wooden blocks about 3x4 in. in section, having four grooves cut into them, were used to hold the plates in place. The concrete was hauled to the mixers in dump barrows, runways being built and shifted as the work progressed.

LABOR FOR LOCK CONSTRUCTION—The following is the labor distribution for the lock work: Operating concrete mixer—one engineer running mixer engine, three men dumping cement from platforms, three men dumping sand and gravel, one engineer and one fireman on derrick boat, one man below mixer keeping track clean, one to two men on car placing and hooking buckets. Placing concrete in forms—one engineer and one fireman on traveling derrick, one signalman on top of forms, three to four men in the forms spading and distributing concrete. Driving piles, stationary leads—one foreman, one engineer and three men. Driving piles, swinging leads—one foreman, one engineer and five men.

NAVIGABLE PASS COFFER-DAM

The second coffer-dam (No. 2 on Fig. 1) inclosed 480 ft. of the foundation of the navigable pass, and when connected to the river arm of the lock coffer-dam the portion of the latter included between the upper and lower arms was torn out, making one continuous coffer-dam, which was unwatered by two pump boats, one near the upstream outer corner of the lock and one at the lower side of the pass.

Before the lower arm of this coffer-dam was completed, the crib required below the navigable pass was built in

FIG. 4. VIEW OF ONE OF THE COFFER-DAMS, SHOWING METHOD OF CONSTRUCTION

three sections and sunk. Timber was laid across a portion of the top of each crib as sunk, and it was loaded with heavy stone. After the coffer-dam was unwatered and

FIG. 5. GENERAL VIEW OF CONSTRUCTION OF LOCK AND DAM NO. 9, OHIO RIVER

(Looking from the lock side across the river, and showing land and river walls and gate recesses in the locks, and the coffer-dam for part of navigable pass and of lock)

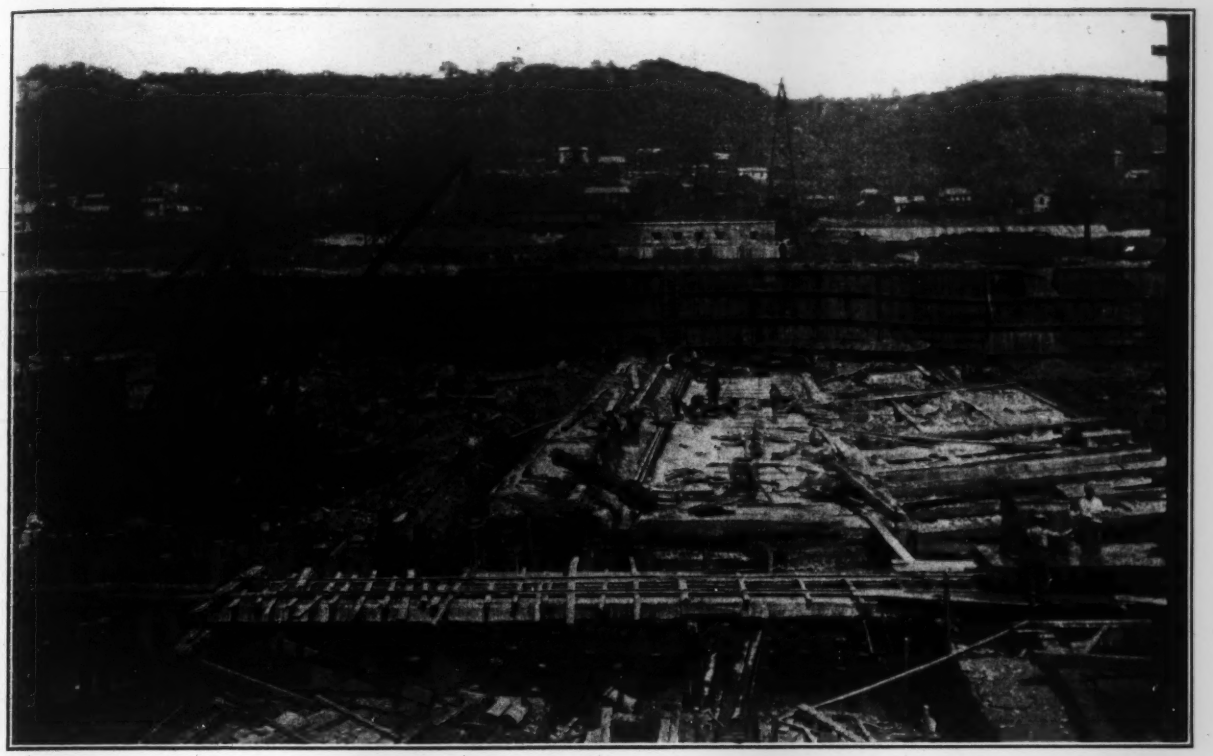


FIG. 6. INSIDE OF COFFER-DAM DURING CONSTRUCTION OF PART OF NAVIGABLE PASS, OHIO RIVER LOCK AND DAM NO. 9

while piledriving and concreting were in progress, the heavy stone was removed from the top of the crib and placed at its lower side. The timbers were then removed and the pockets filled with stone, no one of which exceeded 5 cu.ft. in volume. After sinking the crib, the lower arm of the coffer-dam was completed, the dividing wall between the lock coffer-dam removed, and pumping commenced. The two derrick boats inside the lock coffer-dam and the third boat left in the pass were used for the excavating, piledriving and concrete placing.

The concreting of the floor of the navigable pass was carried on from a mixing plant mounted on the upstream pass wall of the coffer-dam, the concrete being moved along the narrow-gage track shown in Fig. 1, parallel with the pass.

GUIDE WALL COFFER-DAM

At the close of the season of 1911, the navigable pass coffer-dam was removed, and the opening in the river arm of the lock coffer-dam rebuilt. In the spring of 1912 285 ft. of upper and 270 ft. of lower arm of the lock coffer-dam were removed, and two wings added (shown as No. 3 in Fig. 1) inclosing the two guide walls as well as the lock proper. This coffer-dam was one of the largest ever unwatered on the Ohio River. It was 2600 ft. long on the river side, making a total perimeter of about 4500 ft. The very large pumping plant required to unwater it is described in detail toward the end of this article.

For the concreting of the extended walls inside of this dam, two concrete mixers were used, one at the river arm of the upper guide-wall coffer-dam and the second below the upper end of the lower guide-wall coffer-dam. Two derrick boats on the outside of the coffer-dam kept the mixer supplied with material, the cement being loaded on barges from the cableway. Four traveling derricks, two for each guide wall, drove round piles, erected forms and

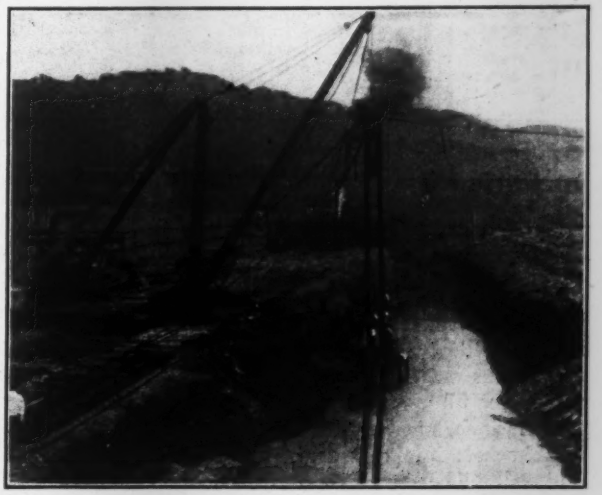


FIG. 7. DRIVING PILES WITH HANGING LEADS

placed concrete and riprap, but stationary leads were used in driving the sheetpiles for both walls. No derrick boats nor fixed derricks were used inside the coffer-dam.

WEIR AND ABUTMENT COFFER-DAM

The coffer-dam marked No. 4 on Fig. 1 was started July 9, 1912, to inclose the abutment to the weir, beartrap No. 2, and piers Nos. 2 and 3 in the beartrap weir.

As on the preceding work, the cribs were built and sunk before the completion of the lower arm of the coffer-dam. Pumping was commenced Sept. 7, and piledriving Sept. 12.

The layout of the plant inside this dam is shown on Fig. 1. It included one pump boat at the downstream arm of the coffer, two concrete mixers, one at the middle of the downstream arm and one at the upstream arm, a fixed derrick about 20 ft. above the upper side of the beartrap foundation, concrete tracks shifted from time to time to suit the occasion, two traveling derricks erected on the beartrap crib for concrete distribution and driving piles, a third derrick for the same purpose on the weir crib and a fourth traveling derrick above the Chanoine weir foundation, driving round piles, placing concrete and riprap, etc.

Esplanade

During the winter of 1911 and spring of 1912, the esplanade fill and paving on the West Virginia shore back of the locks was carried on. The work was completed in 1913. The fill was made from material dumped by scows in the lock chamber and lifted over the land wall by clam-shell buckets into cars running on tracks back of the land wall. These tracks were moved to continue the fill. The 6-in. concrete paving back of the land wall was deposited from barrows which were wheeled to the proper locations from a mixer located on the land wall of the lock. The mixer was loaded from barges floating inside the lock, by a fixed derrick alongside.

Beartrap Weirs

The coffer-dam for the final closing (marked No. 5 on Fig. 1) inclosed the two beartrap weirs and 120 ft. of unfinished pass, and was started in May, 1913. Part of the upper and lower arms of the abutment coffer-dam had been left standing at the close of the 1912 season. Connection was made to these parts by building at both ends of pier No. 3 and extending riverward to the new coffer-dam. Construction was practically the same as in the previous coffer-dam. The new dam, however, proved to be rather leaky, and a false or inner coffer had to be built around several leaks which appeared. The location of the plant for this final coffer-dam is shown in Fig. 1; it does not differ materially from that for the other dams.

Superstructure

In July, 1913, the Independent Bridge Co. started the erection of the beartrap steelwork. It was completed before the end of the season. The remainder of the superstructure was completed in the 1914 season.

Fig. 8. Inside of Ohio River Lock No. 9 during Construction

Pumping Out Coffer-Dams

Data on the pumping of coffer-dams are rather scarce, so the following figures are given on one coffer-dam (the lock and guide-wall coffer, Nos. 1 and 3, Fig. 1), the others being similar.

The equipment was as follows:

No. 1 pump boat, 28.2x69x4.4 ft. (draft 3.2 ft.).
- 2—15-in. (18-in. suction, 15-in. discharge) centrifugal pumps.
- 1—8-in. (10-in. suction, 8-in. discharge) centrifugal pumps.
- 2—horizontal engines, 2 cyl. 14x18-in., 60 hp. each.
- 1—horizontal engines, 2 cyl. 11x14-in., 40 hp.
- 4—Brownell boilers, 60 hp. each.
- 1—vert. Troy engine, 1 cyl. 8x10-in. with 7.5 kw. generator.
- Pump capacity—Min. total head (18.2 ft.)—30,000,000 gal. (24 hr.).
- Max. total head (24.0 ft.)—10,000,000 gal.
- Fuel consumption, 450 bu. max.; 350 bu. min. 24 hr.

No. 2 pump boat, 30.3x75.3x5.0 ft. (draft 2.5 ft.).
- 3 pumps, same as for No. 1 boat.
- 1—horizontal engine, 2 cyl. 14x16 in., 55 hp.
- 1—horizontal engine, 2 cyl. 14x20 in., 65 hp.
- 1—horizontal engine, 2 cyl. 11x14 in., 40 hp.
- 3—Brownell boilers, 70 hp.

1 vertical engine, 1 cyl. 7x8 in., with 7.5 kw. generator.
Pump capacity—Min. total head (19.0 ft.)—30,000,000 gal. (24 hr.).
Max. total head (26.5 ft.)—10,000,000 gal. (24 hr.).
Fuel consumption 350 bu. max.: 250 bu. min. (24 hr.)
There is quite a fuel saving on this boat on account of the outside of the boilers being lined with brick and asbestos; also on account of the feed water being heated before entering the boilers.

The time to unwater this coffer-dam, containing about 40,000,000 gal. of water at river stage 10.5 ft., and both boats pumping at maximum, was 48 hr. The leakage during the first 24 hours probably amounted to 30,000,000 gal., and the six pumps, running at maximum capacity, would remove 60,000,000 gal., thus leaving 10,000,000 gal. Since the lift was becoming greater each hour, and the leak was decreasing very slowly, another 24 hours was necessary to complete the unwatering of the coffer-dam. When the dam was new it was unwatered in about 60 hr. The extra time was due to the fact that the coffer-dam was new and the leakage much greater.

This coffer-dam inclosing the two guide walls each consists of two arms 16x20 ft. about 800 ft. long, while that inclosing the lock proper was 20x20 ft. and 1000 ft. long, making approximately 2600 ft. on the river side all filled with sand and gravel. In addition there was about 1900 ft. of shore, from which there was considerable drainage. The perimeter of the inclosed area was about 4500 ft. At a stage of 2.5 ft. above low water, only three 15-in. pumps were necessary to keep it unwatered.

Plant

The plant for the entire work was as follows:

3 derrick boats, 3-drum engines.
2 derrick boats, 2-drum engines.
1 dredge boat, 2-drum, 50 hp. and 1-drum, 10 hp. engines; 60 hp. boiler.
1 stern-wheel steamboat, 22x104 ft., 6 barges and 2 scows.
1 pump boat, 4—60 hp. boilers, 2—60 hp. and 1—40 hp. engines, and 2—15 in. and 1—8 in. centrifugal pumps.
1 pump boat, 3—70 hp. boilers, 1—65 hp., 1—55 hp. and 1—40 hp. engines, 2—15 in. and 1—8 in. centrifugal pumps.
4 traveling derricks, 21 hp. engine and 20 hp. boiler.
1 sand digger, 60 hp. boiler, 30 hp. marine engine, and 10 hp. 2-drum engine.
4 fixed derricks, 75 to 80 ft. booms.
4 sets swinging piledriver leads, with steam hammer; weight of striking parts, 3000 lb.
1 set stationary leads, 36 ft. high.
2 concrete mixing plants complete with 1 yd. machines.

Labor Cost Data, for Seasons of 1912 and 1913

The following notes on labor costs are of value:

Excavation	$0 104	per cu.yd.
Driving sheetpiles	0.105	per lin.ft.
Driving round piles	0.0605	per lin.ft.
Placing concrete	0.38	per cu.yd.
Erecting forms	0.29	per cu.yd.
Making sheetpiles (length 25 ft.)	0.92	per pile
Building coffer-dam	0.97	per lin.ft.
Removing coffer-dam	0.41	per lin.ft.
Building crib	3.306	per M. ft. bm.
Placing riprap	0.21	per cu.yd.
Fill	0.066	per cu.yd.
Framing and placing beartrap and sill timber	11.30	per M. ft. bm.
Erecting beartrap steel	0.0074	per lb.
Placing pipe	0.105	per lin.ft.

EXCAVATION:

Practically all excavation was made with dredge and derrick boats, equipped with orange-peel and clamshell buckets, 1 yd. capacity, before unwatering the coffer. Material was sand and gravel, closely consolidated.

SHEET PILES:

Piles were driven with stationary and swinging leads. Average length of piles below cutoff elevation was 22 ft. Hardpan, about 1 ft. thick, from 5 to 10 ft. above rock was encountered.

ROUND PILES:

Cost varied each month from $0.05 to $0.07 per lin.ft., in proportion to the rise of the rock. At the guide walls the cost was least, and greatest at the abutment, where the rock was much higher.

CONCRETE:

Cost included mixing, placing and hauling; also of lifting the sand and gravel to the mixer by means of a derrick boat. The concrete was hauled on cars by means of a continuous cable.

FORMS:

Includes cost of placing hurters, sills, horseboxes and valves; 3559 cu.yd. consisted of lock paving, requiring practically no formwork.

MAKING SHEETPILES:

Sheetpiles were made from 10x12 in. timber, having tongues and grooves 3 in. deep.

BUILDING COFFER:

Covers framing, sheeting and filling coffer, but not cost of material; 16 ft. deep.

REMOVING COFFER:

Actual cost of removing and disposing of coffer; 1123.2 ft. was 16 ft. and 1599 ft. was 10 ft. coffer.

BUILDING CRIB:

Includes framing and bolting of timbers and sinking crib. Filling with stone not considered under this heading but as riprap.

In the above cost data the following rates of pay for 8-hr. work were used. It varied for the two seasons, being higher for 1913 than for 1912. The first rate refers to 1912, and the second to 1913.

Laborers, $1.75 and $2.00; Mechanics, $2.00 and $3.00; Carpenters, $3.00; Pile Driver Men, $2.00; Derrick Boat Engineers, $4.00; Hoisting Engineers, $3.00 and $3.60; Pump Boat Engineers, $3.60; Fireman, $2.00 and $2.40; Pile Driver Foreman, $4.00; Carpenter Foreman, $5.00 and $6.00; Labor Foreman, $3.00 and $3.20; Blacksmith, $4.00; Master Mechanic, $5.00 and $6.00; Structural Iron Workers, $5.00.

TOTAL QUANTITIES AND RATES BID

Designation	Quantities	Rates
16 ft. coffer	5149.2 lin.ft.	$20.00
10 ft. coffer	1609.5 lin.ft.	10.00
Excavation	73469.7 cu.yd.	.60
Fill	86220.8 cu.yd.	.50
Riprap	2455.6 cu.yd.	3.00
Stone paving	263.2 cu.yd.	8.00
Round piles	124692.3 lin.ft.	.50
Sheetpiles	1092905 ft. bm.	60.00 M.
Common timber	674815 ft. bm.	60.00 M.
Deck timber	231100 ft. bm.	60.00 M.
Oak timber	69282 ft. bm.	80.00 M.
Reinforced concrete	117.95 cu.yd.	10.00
Concrete	51428.25 cu.yd.	6.00
Structural steel	929774 lb.	.07
Reinforcing rods	101154 lb.	.07
Forgings	44301 lb.	.07
Bolts	150294 lb.	.07
Iron castings	282677 lb.	.07
Steel castings	181611 lb.	.07
Bronze	1368 lb.	1.00
Pipe, 5 in.	392.6 ft.	3.00
Pipe, 4 in.	2700.5 ft.	3.00
Pipe, 3 in.	1217.3 ft.	1.50
Pipe, 2½ in.	195.3 ft.	1.50
Pipe, 2 in.	654.7 ft.	1.50
Tile drain	874 lin.ft.	1.00

The lock and dam work on the Ohio River is under the direction of the Chief of Engineers, U. S. Army.

Granite Blocks on a Mortar Bed is a new development of the Bureau of Highways, Borough of Manhattan, New York City. In place of the usual 1-in. sand cushion an experimental section of the new Third Ave. pavement in the vicinity of 20th St. has been laid with a 1-in. mortar cushion composed of 1 part cement to 3 parts sand, thoroughly mixed dry and slightly moistened, after the manner of the mortar bed now used exclusively in Manhattan Borough for wood-block pavements. A shallow dry mortar bed was used under several thousand square yards of redressed granite blocks in Schenectady, N. Y., in 1913. After the blocks were laid and rammed, the pavement was flushed to moisten the mortar bed. This is said to be a very satisfactory job. The Third Ave. pavement, New York City, is a part of a pavement laid under the usual specifications for first-class grouted granite block, and the results on the mortar-bed section will be watched with interest. Eugene W. Stern is Chief Engineer of the Bureau of Highways of the Borough of Manhattan.

The Alliance Water Filters

By Thomas Fleming, Jr.*

SYNOPSIS—The special features of this plant are false filter bottoms, an open pipe gallery, manometer type of loss-of-head gages and sampling pump, and the new Venturi type of rate controller.

Alliance is a rapidly growing industrial community located in eastern Ohio, near the headwaters of the Mahoning River, from which it takes its water-supply. It has a population of 16,000 and an average daily water consumption of 4,500,000 gal. The water-supply is contaminated by the sewage of small communities and the

Fig. 1. Water-Filtration Plant, Alliance, Ohio

wastes from homesteads on the watershed above Alliance. In addition, the water is very turbid at times. The turbidity varies from a few parts to several thousand parts per million, with very sudden changes during freshets. Chemically, the water is in good condition for drinking and boiler purposes.

The installation of a mechanical filtration plant was begun in 1912. The plant was completed in the fall of 1913 and has been in continuous operation ever since. It is of the gravity type and is designed to treat 6,000,000 gal. of water per 24 hr. It is located near the pumping station, where the water is lifted from the river to the plant. After treatment, the water is collected in a clear well, from which it is pumped, as formerly, direct into the city mains. Fig. 1 is a general view of the plant.

The plant consists of six 1,000,000-gal. reinforced-concrete filter units located over the clear-water basins and built in two groups separated by a pipe gallery, as shown in section by Fig. 2. The filters are partly covered by a brick building which extends to the coagulant house located at one end of the structure. The filters are manipulated by hydraulically operated valves located in the pipe gallery (Figs. 2 and 3) and are controlled from operating tables (Fig. 4) placed on a concrete platform near the top of the filters. The hard-wash system is used for washing the filters at a rate varying from 15 to 20 gal. per sq.ft. of filter surface per min.

The settling basin is constructed of reinforced concrete and is located near the filters. It has a capacity of 850,000 gal. and its flow line is located just below the tops of the filter-tank walls. The raw water, before entering the settling basin, is treated with alum and soda ash to form a flocculent precipitate in the settling basin. These chemicals are introduced into the raw-water main, immediately outside of the coagulant house, by gravity feed lines. The coagulant house is a two-story brick structure. On the first floor is a pump room in which is located the wash-water pump and the laboratory. These rooms are separated by the entrance hallway to the filter building. The second floor is used for the storage of chemicals and for the chemical tanks and apparatus.

False Bottoms—One of the great problems in connection with the use of the hard-wash system in washing filters has been to distribute uniformly the large amount

*Chester & Fleming, Engineers, Pittsburgh, Penn.

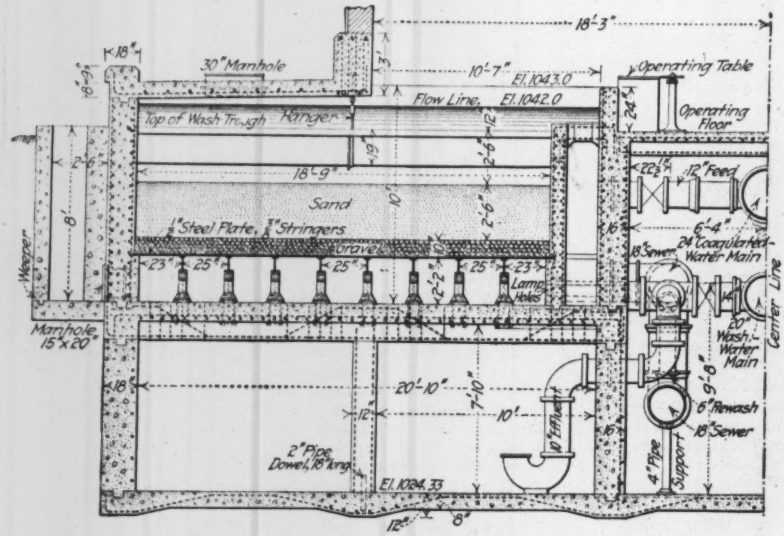


Fig. 2. Half Cross-Section of Alliance Water-Filtration Plant

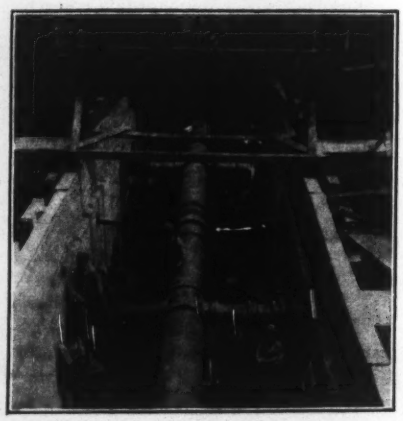


Fig. 3. Pipe Gallery under Construction

of water required over the bottom of the filter. With the old pipe-manifold type of collecting system and also with the systems consisting of laterals of concrete gutters and brass plates, considerable trouble has been experienced in getting a uniform distribution and in preventing greatly increased pressures over the inlet points, which, in some cases have seriously injured the collecting system, and in others, have secured a very uneven distribution of the wash water. By using a false bottom, such as is installed in the Alliance plant, these troubles are eliminated, and, in addition, it is possible to clean out or inspect the collecting system at any time by simply closing down one filter and entering the manhole to the false bottom. With the other types of collecting systems above referred to, whenever the laterals became clogged with sand or trouble was experienced with growths, it was necessary to remove all of the filter material and chop out the manifold from the surrounding concrete. This is, of course, eliminated by the use of a false bottom. The use of false bottoms in filters is, however, not a new idea, as they were used a great many years ago in the old type of steel filters, but there have been only a few installations in which they have been adapted to the use of the modern reinforced-concrete filter tanks and to the distribution of the wash water in the hard-wash system.

The false bottom is constructed as shown by Figs. 2, 5 and 6. Eight-inch I-beams are built into the concrete filter tank at a distance of 18 in. from the bottom of the beam to the bottom of the tank. These beams are supported by steel columns, spaced 6 ft. c. to c. The I-beams are spaced 2 ft. c. to c., and support ½-in. steel plates, built in sections, and bolted every 6 in. to the I-beams. These plates are tapped every 6¼ in. in both directions with ⅜-in. pipe for the brass strainers. On the outside of each filter there is a concrete manhole extending from the false bottom to the surface of the ground. At the bottom of this manhole there is a 15x20-in. elliptical manhole entrance to the false bottom. The casting for this manhole is built into the concrete wall of the filter and the cover is bolted with stud bolts to the casting and arranged so that it can be easily removed. On the opposite side of the false bottom there are two 6-in. cast-iron lamp holes, extending horizontally from the false bottom to the pipe gallery, and constructed similar to the entrance manhole. These lamp holes serve as a means of ventilation for the false bottom, when the operator is inspecting the latter. Clear water is taken off and wash water is admitted through a 14-in. connection from the pipe gallery.

Pipe Gallery—The pipe gallery is so arranged that every valve or section of pipe is readily accessible. The sewer has to be placed at the elevation shown (Fig. 2) in order to readily drain to the stream under ordinary freshet flows. It was found on estimating the cost of construction that there was very little difference in constructing a separate sewer for each side of the pipe gallery over the cost of constructing one sewer through the center, due to the fact that a great many additional specials and connections would have been required for the central sewer to connect up each individual filter tank. By constructing the two sewers, headroom is provided for walking through the gallery without interruption.

Loss-of-Head Gages—Each filter is equipped with a loss-of-head gage of the manometer type and a sampling pump located on the operating table (Fig. 4). This apparatus was designed by Chas. H. Humphreys and is operated by creating a partial vacuum in the globes at the tops of the apparatus by means of a small water ejector located in the operating table. It is only necessary to create this vacuum in the loss-of-head gage occasionally, as the accumulation of air from water standing in the gage columns is very slow. As soon as the vacuum is created in these bulbs the water rises in the gage columns to a point just below the vacuum pipe opening near the top of the bulb. These columns are connected to the water above the sand in the filter and to the outlet clear-water connection from the filter respectively, and on the gage are connected to the mercury column located in the center of the gage. The difference in the height of the

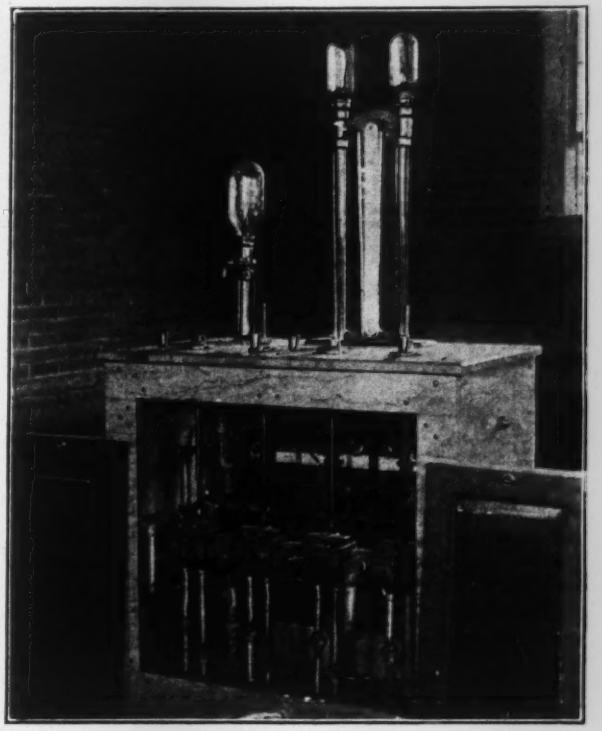


Fig. 4. Operating Table, Alliance Water Filters
(The manometer type of loss-of-head gage may be seen at the right and the sampling pump at the left)

mercury in the manometer tube, therefore, gives a direct reading of the loss of head in the filter when the filter is operating; and when operation is reversed and the filter is being washed it will give a direct reading of the wash-water pressure. This gage does away with the complicated working parts of the ordinary float gage, and, in addition, gives the operator the data necessary to control accurately the rate of wash.

The construction of the gage is simple. The gage columns are connected by cement joints to the glass bulbs at the top, and by tight stuffing-box connections to the manometer tube and to the pipes to filter. The vacuum tubes are carried up through the center of the gage columns to a point near the top of the glass bulbs and are connected by small valves in the operating table to the vacuum end of the water ejector. The manometer tube is full of water above the mercury.

Sampling Pump—The sampling pump is constructed in a similar manner and is connected to the clear-water outlet from the filter. By turning a handle controlling

the ejector in the operating table a vacuum is created in the bulb on the sampling pump. This draws the clear water until it completely fills the bulb, when the ejector is shut off and the faucet of the sampling pump is opened for taking a sample.

RATE CONTROLLERS—The rate controllers used on the Alliance filters are of a modified Venturi meter type which was developed by the manufacturers in connection with the Alliance installation. They consist (Fig. 7) of a Venturi meter, with a hydraulically operated gate valve on the outlet controlled by a pilot valve. This, in turn, is controlled by a diaphragm valve connected to the inlet end and throat of the meter. The diaphragm and pilot valves are placed in a cast-iron box on top of the meter and the diaphragm is further equipped with a scale-beam counterbalance, so that the rate of filtration can be adjusted as may be desired. The movement of the diaphragm, due to any change in pressure from the connections to the Venturi meter, is communicated through a simple system of levers to the pilot valve, which admits water from a pressure line to the hydraulic cylinder of the gate valve, gradually opening this valve as the loss of head in the filter increases until the valve is full open, but always maintaining a uniform rate of filtration.

OPERATING RESULTS—Shortly after the filter plant had been placed in operation, the value of the false bottom was appreciated as a means of ready access to the collecting system. The gravel in the filters was too coarse and considerable filter sand worked through the gravel to the false bottoms. This was detected by the drop in the sand line in the filters. Each filter was closed down separately, after which the sand was removed from the false bottom with very little expense. A finer layer of gravel was then installed over the filter gravel.

FIG. 5. STRUCTURAL FRAMEWORK

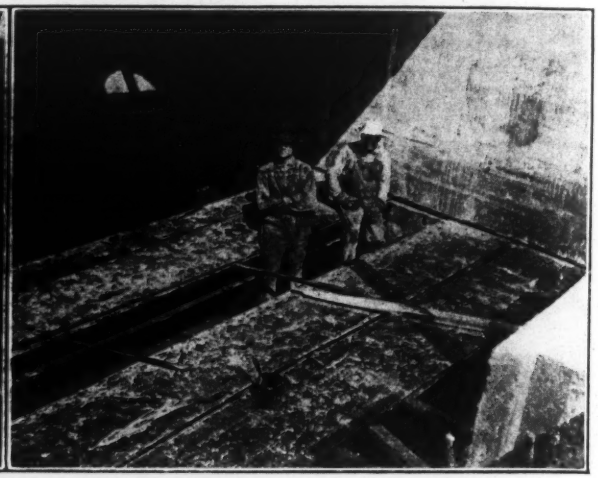


FIG. 6. PLACING STEEL PLATES

FALSE BOTTOM OF MECHANICAL FILTERS, ALLIANCE, OHIO

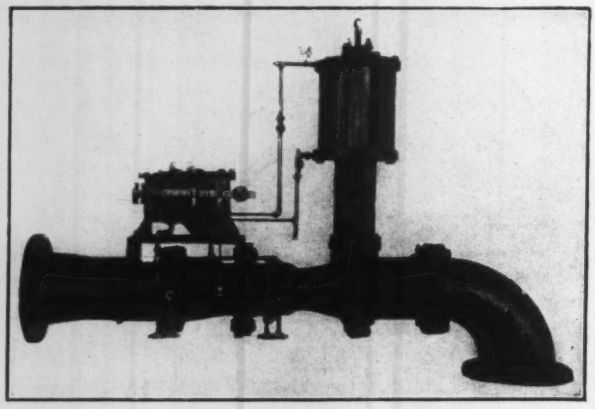


FIG. 7. VENTURI FILTER-RATE CONTROLLER, WITH PILOT-OPERATED HYDRAULIC VALVE

Several inspections have been made of the distribution of the wash water over the false bottoms at rates ranging from 15 to 20 gal. per sq.ft. per min., and it has been found that even under the highest rate the distribution is apparently perfect. In inspecting the false bottoms it has been found advantageous for the operator to use a small wooden two-wheeled truck on which he lies and propels himself around with his hands. An electric light is admitted on an extension cord from one of the lamp holes in the filter gallery.

The apparatus has worked very satisfactorily, the only trouble experienced being the breaking of some of the glass bulbs on the gages through the carelessness of the filter attendant in polishing the brasswork around them.

The plant was designed and constructed by Chester & Fleming, engineers, of Pittsburgh, Penn., of which firm the writer is a member. The Pitt Construction Co., of Pittsburgh, was the contractor. The gages and the sampling pumps were furnished by the Humphreys Gauge Co., and the Venturi type of controller by the Builders Iron Foundry, of Providence, R. I.

The Street Paving of Chicago, in the 21 miles of street in the downtown district bounded by Lake Michigan, the Chicago River and 12th St., aggregates 583,285 sq.yd., which at an average cost of $3.54 represents a cost of $2,058,936. These figures are given in the report by Alvord & Burdick, consulting engineers, on the underground public utilities. The report classifies the paving as follows:

	Sq.yd.	Per yd.	
Granite block	321,279	$4.00	$1,285,116
Wood block	142,782	3.55	506,876
Asphalt	46,642	3.00	139,926
Brick	7,404	1.75	12,957
Asphaltic concrete	65,178	1.75	114,061

The Billerica Garden Suburb

By Arthur C. Comey*

The Billerica Garden Suburb, Inc., at North Billerica, 21 miles from Boston, marks the first conclusive stage in bringing into existence in this country the improved methods of housing for workingmen proven so successful in England.† For nowhere else in the United States, so far as is known, have the five essential elements—site-planning, limited number of houses per acre, wholesale operations, limited dividend, and participation by the residents—been combined in an undertaking designed to meet the needs of the workman earning $12 to $20 per week.

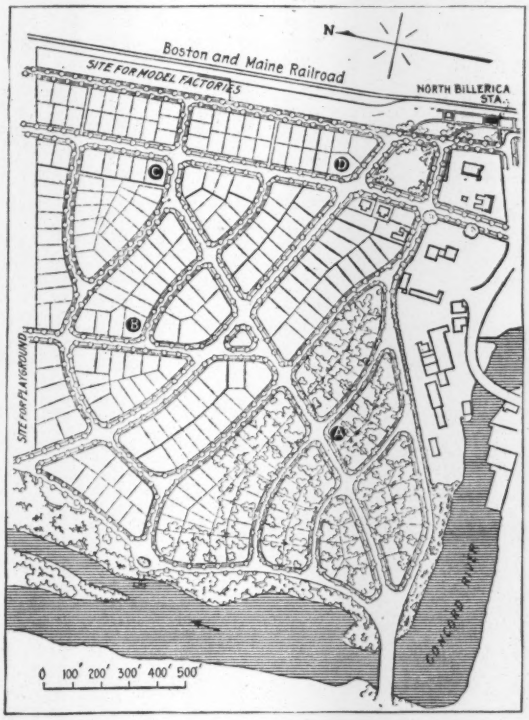


Fig. 1. Plan of Billerica Garden Suburb

(A, Purchase zone. B, Zone reserved for copartnership. C, Renting zone. D, Special zone)

The establishment at Billerica of the $3,000,000 Boston & Maine repair shops, which opened in February, 1914, with 1200 operatives, with a prospect of 2000 to 3000, created a great demand for workingmen's houses in a formerly rural community. Furthermore, other manufacturers are locating nearby in order to utilize the supply of labor. This means a steady influx of 10,000 people or more.

Options were placed in April on a tract of 54 acres, favorably located, adjoining the North Billerica Station and the present village center, where schools and other public buildings make immediate development possible. This area lies less than a mile from the shops and, furthermore, a free workingmen's train carries the men directly from the North Billerica Station into the works. The cost of this property was far below that demanded by real-estate operators farther from the work and with much less attractive surroundings.

The tract was then laid out after the plan of the writer, and is now being developed along advanced garden-suburb lines, with an average of five to six families per gross acre. Of special æsthetic value is the river frontage and a large grove of pines in the southwest section. The underlying fine gravel and sand furnish abundant material for concrete construction, and greatly simplify the grading of roads and sanitary problems. Water is piped upon the estate, supplying 16 houses, in the southeast corner, which yield an income sufficient to pay all carrying charges not chargeable to development.

The 54 acres held under option were taken over and a company formed in June, including as two of its directors the Superintendent of the Boston & Maine shops and the President of the local Board of Trade, who has actively promoted the establishment of the suburb from the start. Dividends are limited to 5% cumulative, and each resident must be a shareholder. A greater or less portion will be turned over to a copartnership society for development by that method. In another section houses will be sold outright on installments. In a third section houses for rent will be built, and in the fourth district the company will construct special buildings as the demand arises for shops, lodgings, boarding houses, etc. (see plan, Fig. 1).

Fig. 2. Cottages in Billerica Garden Suburb, North Billerica, Mass.

Capital to the extent of $50,000 was sought to initiate the undertaking. In August a prospectus was issued, and at that time $16,540 had been subscribed. By October 1 the roads on thirty acres were graded, water was put in, and the first three houses begun. These are now practically ready for occupancy and larger building operations will soon be undertaken. The accompanying view shows two of the new cottages.

*Consultant on city planning and member Massachusetts Homestead Commission, Harvard Square, Cambridge, Mass.

†The Billerica project is the first concrete application of the principles laid down by the Massachusetts Homestead Commission in November, 1913, in its report covering four methods for organizing improved housing companies. Since adopting this report the committee has investigated every opportunity which has appeared for establishing such companies. Of four more or less immediate prospects, that at Billerica was found to combine to an unusual degree the conditions for a successful undertaking.

A 45° Triangle has been adopted as a badge by the Oregon Society of Engineers and its significance thus noted: Its three angles remind us of the client, the contractor and the engineer. The sides of the triangle are typical of right dealing. The two equal sides call attention to the fact that contractor and client have an equal claim on the knowledge, training and attention of the engineer. The right angle should be a constant reminder that each is entitled to a square deal.

History of Attleboro Standpipe of Reinforced Concrete

In 1904 the maintenance of an old wrought-iron standpipe was costing the town of Attleboro, Mass., about $400 per year. It had to be cleaned twice a year and each time a quantity of rust was removed from the bottom (estimated at about a ton). Owing to the relatively large amount of carbon dioxide in the water the structure was rusting very rapidly, and its life was estimated at only 20 years. The old standpipe was 30 ft. in diameter and 125 ft. high, and because of the corrosion and pitting was rapidly reaching the end of its safe life.

After a careful consideration of all factors, reinforced concrete was decided upon for a new structure, 50 ft. in diameter and 102 ft. high, the estimated cost of which was $35,000.* The cost of the proposed concrete structure was shown to be 10% cheaper under the prevailing market conditions than a new steel standpipe of the same capacity (1,500,000 gal.). At this time the reinforced-concrete standpipes at Fort Revere, Mass., and Milford, Ohio, were the only ones of any size, and the proposed new Attleboro structure was to be larger than either of these. Bids were received in August, 1904, and the following month the contract was let to the Aberthaw Construction Co., Boston, Mass., for $34,365. The consulting engineer for the town of Attleboro was F. A. Barbour, of Boston, Mass.† The design of the reinforcement and the character of the concrete mixture were by the terms of the contract in the hands of the contractor, who was required to guarantee a water-tight structure for the term of one year.

It was found impossible to complete the standpipe before the cold weather of the winter of 1905-06, but it was used during the winter by agreement with the contractor before the specified inside plastering had been applied. When first filled a number of leaks developed, but these largely stopped after some weeks' use. It was then anticipated that when the interior plaster was applied in the spring, the leaks would cease entirely.

The standpipe was conditionally accepted and put into commission Dec. 27, 1905, and it continued in uninterrupted use until May 15, 1906. During this period the leaks were of trifling importance. However, during extreme cold weather the concrete exterior first exhibited a scaling or spalling off. This began about 5 ft. from the bottom of the tank and extended to a distance of 15 ft. above the base. This scaling was at that time laid to the freezing of water in pockets or cavities supposed to have existed on the outside of the steel, due to slight moving of the steel in the forms when the concrete was placed.

On May 15 the standpipe was emptied and the contractor began plastering the inside (first coat, one part cement and one part sand with 2% hydrated lime; the three other coats, one part cement and one part sand). While this was being done the outside, where the concrete had scaled off, was repaired by digging around the outer row of steel reinforcement, putting on at intervals clips of ¾x⅛-in. iron, bolted through, on which to fasten additional reinforcement. The mortar was forced into the cavities between and around the clips by throwing it a distance of 4 to 5 ft. This process was continued until the mortar covered the entire surface of the patch, so that no more plastering could be bonded on. Over this surface was placed a net of expanded metal, forced over the iron clips, and held on by bending them over, and then a coat of mortar was troweled over and into the interstices of the expanded metal. When this patching was complete the outside surface was apparently as good as ever.

About the same time the contractor began work to make the interior water-tight, as he was compelled to do by the terms of his contract, under a penalty of forfeiting a $10,000 bond. The Sylvester process wash was

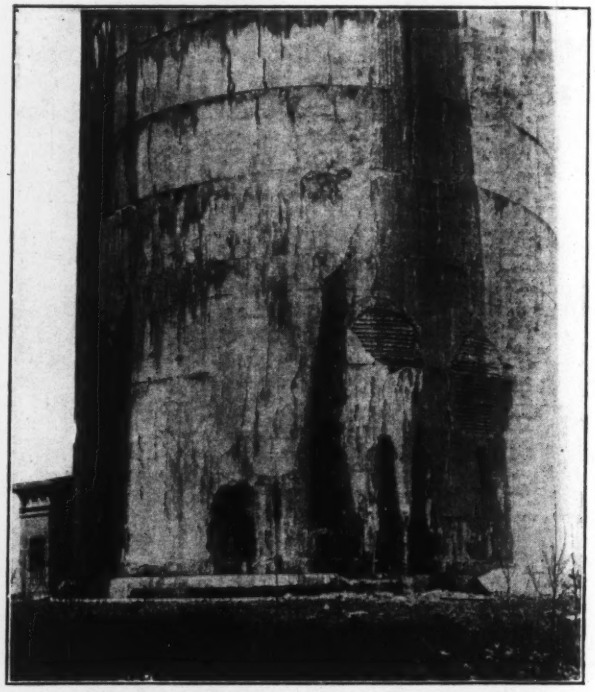


FIG. 1. ATTLEBORO REINFORCED-CONCRETE STANDPIPE AS IT LOOKED IN 1914

used and for the time being proved successful. The standpipe was filled on Oct. 28, 1906. On Dec. 6 the structure was formally accepted, but by the terms of the contract it was to be maintained by the contractor for one year from the date of final acceptance.

Within a few weeks after filling leaks developed, but these varied from time to time, and under certain conditions of the atmosphere the exterior appeared to be perfectly dry. This gave rise to the theory that part of the moisture, at least, was due to condensation from the atmosphere. In the annual report of the town water commissioners for the year 1906 it is recorded:

> There has been no time since the beginning of the structure that the commissioners or their engineer have believed that it was a mistake to adopt this type of structure.

In 1907 it is on record that the sum of $579.20 was expended on the standpipe and appurtenances, although the details are not given.

In 1908 the sum of $940.26 was similarly spent. The official report for this year states that the standpipe continues in satisfactory condition, but that in the coming year it would probably be advisable to draw off the

*A full description of the construction work may be found in "Engineering News," Feb. 21, 1907.

†Mr. Barbour has had nothing to do with the standpipe during the last five years.—EDITOR.

water and remove whatever deposit had accumulated. The possible danger from lightning was considered, and as a precaution a lightning rod with five wrought-iron points was erected on the dome.

In 1909 the records show that $661 was expended on the standpipe and appurtenances. During the summer of this year the structure was visited, and its condition described, by a member of the editorial staff of ENGINEERING NEWS (see issue of Aug. 19, 1909, p. 199). It is there stated:

> Summarizing, it may be said that after 2½ yr. of constant use the standpipe shows three very minor leaks, the danger from which is a possible future deterioration rather than a sudden failure of the wall structure, and a decidedly disfiguring surface efflorescence, which is an esthetic and not a structural defect. These observations were made on a midsummer's day, when the conditions were most favorable to the standpipe.

During 1910 several minor leaks developed which were repaired by grouting with air pressure on the exterior, the standpipe remaining full of water. The commissioners in their report for this year state that they felt assured no mistake had been made in selecting a concrete tank, because of the number which had since been erected in other places. During 1911 no mention was made of the structure in the reports of the water commissioners.

In 1912 the commissioners found the standpipe in sore need of repair. They then stated that it had been in an imperfect condition from the time it was first filled with water; in the words of their report, "like some other parts of the plant, no amount of imagination will make it other than badly defective." To repair the structure would have required its being empty a considerable period of time and on account of inadequate pumping facilities the commissioners were unwilling to assume the responsibility of supplying the town with water for many days without the use of the standpipe. They were in agreement that the structure stood much in need of repair, but nothing was done owing to unwillingness to go to the expense of increasing the pumping facilities.

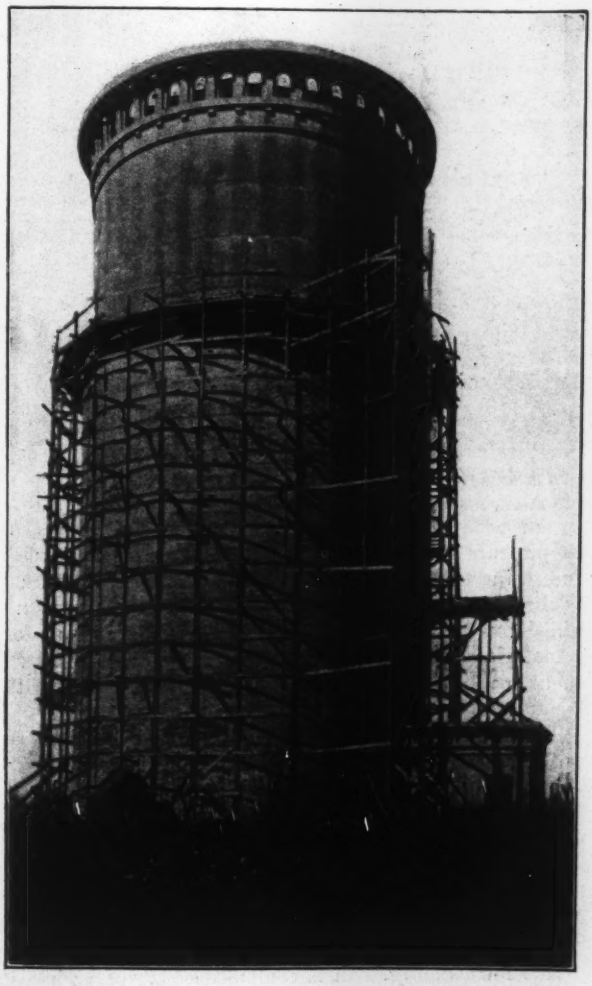


FIG. 2. ATTLEBORO STANDPIPE WITH BRICK-WALL CASING UNDER CONSTRUCTION

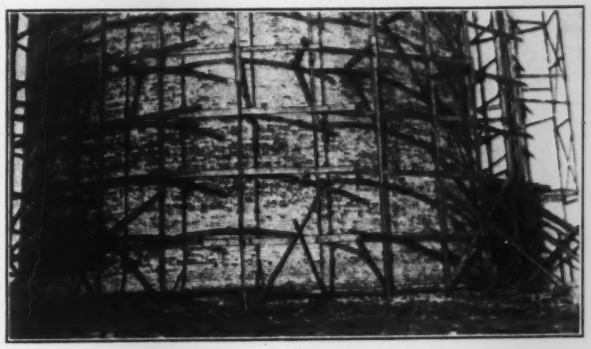


FIG. 3. CLOSE VIEW OF NEW BRICK WALL OF ATTLEBORO STANDPIPE

Two years passed and the appearance of the exterior of the standpipe began to cause alarm to the general public. Although this surface disintegration did not necessarily reflect upon the safety of the structure, the accompanying view, Fig. 1, shows that there was reason for this apprehension on the part of laymen. The standpipe was leaking badly and large pieces of concrete were spalling off the exterior so as to expose the reinforcing rods. The whole structure was unsightly and well calculated to excite popular distrust.

After a study of this and similar standpipes the superintendent of the water-works at that time, Herbert F. Conant, decided that the only satisfactory method of waterproofing the structure was the application of an interior asphaltic coating, as had already been done in the case of the Westerly, R. I., standpipe. The failure of the Sylvester process wash was held to be caused by hardening, brittleness and cracking. Accordingly, in the summer of 1914 a contract was let to F. W. Bird & Sons, of Walpole, Mass., for waterproofing the interior by the methods adopted by this firm at Westerly. The contract price was $3000, with a 5-yr. guarantee.

The waterproofing process used is as follows: (1) Cement to the interior surface three layers of "Neponset waterdyke felt," lapping each sheet 24 in. over the preceding one, until the whole interior receives not less than three layers of felt thoroughly cemented together; (2) on top of this coating apply a second course consisting of two layers of felt thoroughly cemented together and to the two layers already in place. In this second course the sheets overlap 18 in. After the interior receives not less than five layers of felt it is given a heavy final coating of hot asphaltic compound, the complete waterproofing forming a tough elastic membrane of 12 separate and distinct layers.

To waterproof the tank by this method it was first emptied, cleaned and thoroughly dried out by removing the manhole cover in the bottom and the cover on the roof, creating a strong draft, which dried out the interior in three days.

Actual work was started at the bottom; the walls were scrubbed with wire brushes and the first coat of asphaltic compound painted on. To simplify matters the five coats were applied in successive 5-ft. stages from the bottom up by working from a floating platform. At the top a band of iron was placed to prevent the waterproofing from tearing loose.

Attention was then directed to the exterior of the standpipe, where the scaling of the concrete was attributed (by Mr. Conant) to expansion and contraction due to temperature changes. Hence, to lessen the effect of these changes it was proposed to surround the structure with an 8-in. brick wall, with a 2-in. air space between it and the exterior of the standpipe. A contract was let for this work, originally for a wall only 60 ft. high; but subsequently it was determined to carry it to the top (102 ft.) by another contract. This wall is to cost complete $5500. The work was interrupted by the coming of cold weather last fall. Before the brickwork was started the places where the concrete had spalled off, exposing the reinforcing rods, were carefully plastered over with cement mortar. Altogether, the sum expended on repairs in 1914 amounted to $9000, and the structure was out of commission for over two months. Figs. 2 and 3 give an idea of what the standpipe will look like when completed.

Weep holes have been left in the bottom of the brickwork to prevent the accumulation of water in the air space and probable damage to the brick wall by freezing. The weep holes are also expected to give warning of any considerable leak which might indicate a serious condition of the reinforced-concrete wall.

Multiple-Arch Dam to Retain Quartz Mill Tailings

The multiple-arch reinforced-concrete dam of the Eastwood type recently completed to store the tailings from the quartz mill of the Kennedy Mining & Milling Co. near Jackson, Calif., is the fourth dam of this type built in California, and while considerably lower than the earlier three is somewhat out of the ordinary on account of its use and its design. Quartz mill tailings consist of finely divided rock suspended in water and vary from an almost watery consistency to a viscous mass taking an angle of repose. In designing the dam an assumption was made of liquid loading with a liquid having a weight of 75 lb. per cu.ft. When thin enough to exert hydrostatic pressure the tailings do not weigh this much, but before they reach this weight they become so viscous that they exert a pressure limited to the angle of repose that they then assume. According to the designer, practically the greatest pressure that can be exerted on a débris dam is that due to the full hydrostatic pressure of water, for as soon as the débris begins to settle to the bottom the pressure will decrease until the dam is nearly a retaining wall for a material having a large angle of repose and a consequent loading less than the hydrostatic water load with the full dam.

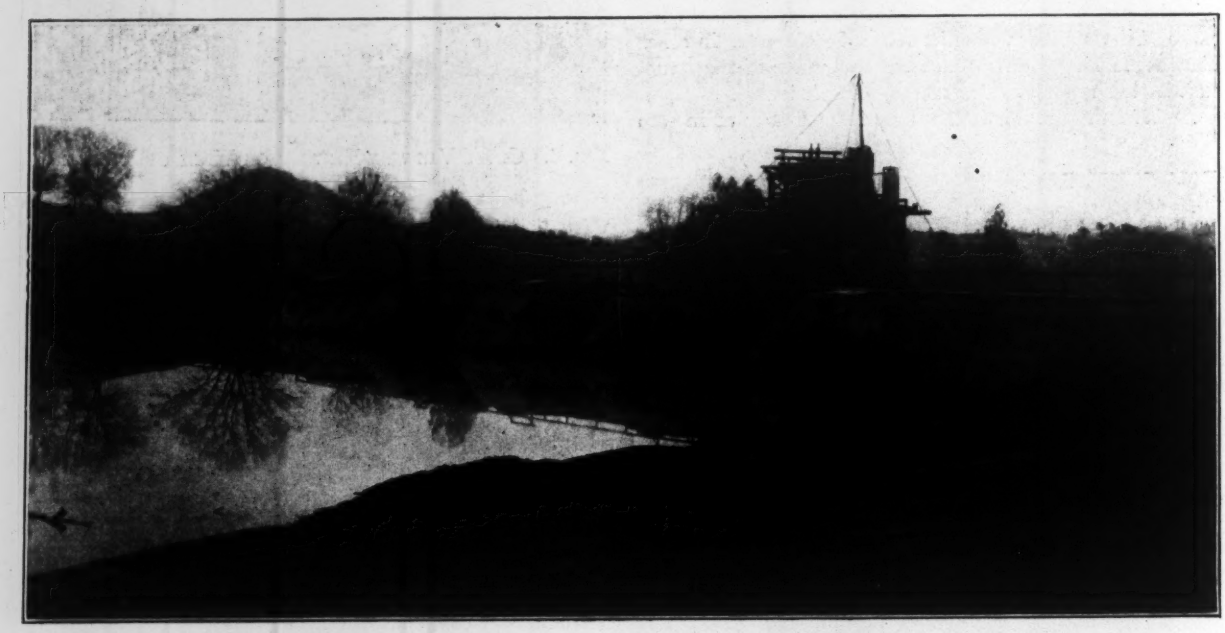


FIG. 1. DAM TO RETAIN QUARTZ TAILINGS, KENNEDY MINING & MILLING CO., CALIFORNIA
(Designed by John S. Eastwood)

The dimensions of the Kennedy dam may be tabulated as follows:

Length of crest	455 ft.
Height above surface	30 ft.
Height above foundations	43.8 ft.
Length of spans	40 ft.
Number of buttresses	11
Number of arches	12
Arc of extrados	133° 34′
Radius of extrados	21.8 ft.
Maximum loading	18.85 tons per sq.ft.
Base loading on buttresses	5 tons per sq.ft.
Cubic yards of concrete	1233

As shown in Fig. 1, it is composed of eleven arches of 40-ft. span, each footing against buttresses 1 ft. thick. There is a spillway at one end, 15 ft. wide and 2 ft. deep,

FIG. 2. REAR OF KENNEDY DAM DURING CONSTRUCTION

to allow water to be drawn off for irrigation. The arches, which are three-hinged, have a crown thickness of 12 in. at the top and increase in thickness toward the springing line and toward the bottom. The buttresses are supported laterally by a strut running from end to end and terminating in a counterfort, thus making the buttresses the equivalent of short columns and preventing any lateral vibration.

The foundations were carried to bedrock, a laminated slate, which was reached through clay varying in depth from 4 to 20 ft. The buttresses were assumed to take the full thrust of the arches and were provided with spread footings so that the maximum loading is 5 tons per sq.ft. The toe or base of the arch ring is placed in a tapered trench excavated in the bedrock and the trench filled up with rock surface without forms, making in effect a cutoff wall. For the arch construction wooden forms were used throughout, except for the arch hinges, which were of metal rolled to proper curve. Fig. 2 shows the general type of the forms for the interior of the arches.

The arches themselves are reinforced with old cables placed on a line normal to the arch crown line. Additional reinforcing tied the beginning of the arch section into a corbel extending out from the buttress. At the top of the buttresses protruding rods were left to be used if in the future an expected 20 ft. is added to the top of the dam. The tie beams also are reinforced with cables.

The aggregate for the concrete was a washed quartz and slate, quarried and crushed near the site. The concrete was mixed in a plant immediately above the dam, conveyed to the forms in buggies and deposited through chutes.

In construction the buttresses were carried up first and finished to full height, after which the arch rings were poured, keeping them all at about the same level, in alternate halves to a small height, using a part of the corbel hinge form for the alternate crown hinge form.

The dam was designed by John S. Eastwood, of San Francisco, was built by the Eastwood Construction Co. on the basis of cost plus a fixed sum, and was approved by Col. W. H. Heuer, U. S. A., retired, of San Francisco. Work was commenced June 10, 1914, and the structure was completed Dec. 1, 1914. By the beginning of the present year the dam was practically under its final head.

The Elevated Railways of Chicago have an aggregate of 55.3 mi. of steel elevated structure, but they operate a considerably greater length of line, as some of the roads end with inclines connecting with surface tracks on which the trains are run. The mileage is divided as follows: Metropolitan, 17.6; South Side, 16.2; Northwestern, 12.7; Chicago & Oak Park, 6.8; Union Loop, 2.

The St. Lawrence River at Ogdensburg, N. Y., has a mean annual flow of 252,000 cu.ft. per sec. The drainage area above Ogdensburg is approximately 383,000 sq.mi., of which area 95,600 sq.mi., or nearly 25%, is water surface. The average annual yield is thus about two-thirds of a cubic foot per second per square mile of drainage area. The Ohio River at Cairo has a mean annual flow of about 300,000 cu.ft. per sec., and drains an area of 203,000 sq.mi., so that its average yield is about 1½ cu.ft. per sec. per sq.mi. The great difference in the yield of the two watersheds is, of course, due chiefly to the very much greater annual rainfall over the Ohio drainage basin. The Yukon River in Alaska has an estimated average annual flow of 73,200 cu.ft., and drains an area of about 330,000 sq.mi., thus showing a yield of less than one-fourth cubic foot per second per square mile. The above figures are quoted from an advance bulletin of extracts from water-supply papers of the U. S. Geological Survey.

Municipal Garbage - Reduction Plant, Schenectady, N. Y.

By S. Gertz*

This country's fourth municipally operated garbage-reduction plant was put into operation by Schenectady, N. Y., late in 1914. The first two municipal plants were those at Cleveland and Columbus, the former operating under the Chamberlain system and the latter under the Arnold system. The third plant, at Chicago, was taken over from a private company early in 1914 and put under reconstruction.

Schenectady's plant is operated under the Chamberlain system, which differs slightly from the Arnold system, in general use in this country. In the Arnold system the tankage is discharged from the digesters and then pressed by means of either hydraulic, roller or steam presses, while in the Chamberlain system the pressing is accomplished in the digester immediately after the cooking has been completed.

Schenectady has a population of about 90,000 and produces, at present, on the average of about 20 tons of garbage per day, on the basis of six collection days to the week. The garbage is collected by the city in steel dump carts of the rear-dump type. These carts have a nominal capacity of 2 cu.yd. and carry between 2200 and 2500 lb. of garbage per load.

Unlike the methods in use in Cleveland and Columbus, all of the carts bring their garbage directly to the plant, the longest haul being about 3½ mi. The receiving station is designed so that two carts may be driven into it and their loads dumped into the basement at the same time. The garbage is raked from the basement floor onto a flight conveyor, and is carried up into the digester building and discharged into any desired digester by means of the necessary gates and spouts. (See Fig. 1 for details of the digester building and Fig. 2 for a general view of the plant.)

The six five-ton steel digester tanks are 5½ ft. in diameter and 14 ft. high, and are provided with the necessary steam fittings. After about five tons of garbage has been placed in a digester, together with some added water, the digester is sealed, and the mass cooked by means of live steam. In order to avoid nuisance, all of the vapors given off in cooking are first passed through a scrubber to bring down such particles of garbage as they may carry and to condense the vapors as far as possible, and the remaining vapors are forced through the boiler grates and burned.

After the garbage has been cooked, the free liquor is pressed out of the tankage by forcing live steam through the mass from the top and allowing the liquor and steam to pass through a burlap-covered strainer plate, which occupies the entire bottom of the digester. This liquor flows to settling tanks, where the grease separates from the water by gravity and is pumped to the grease storage tanks.

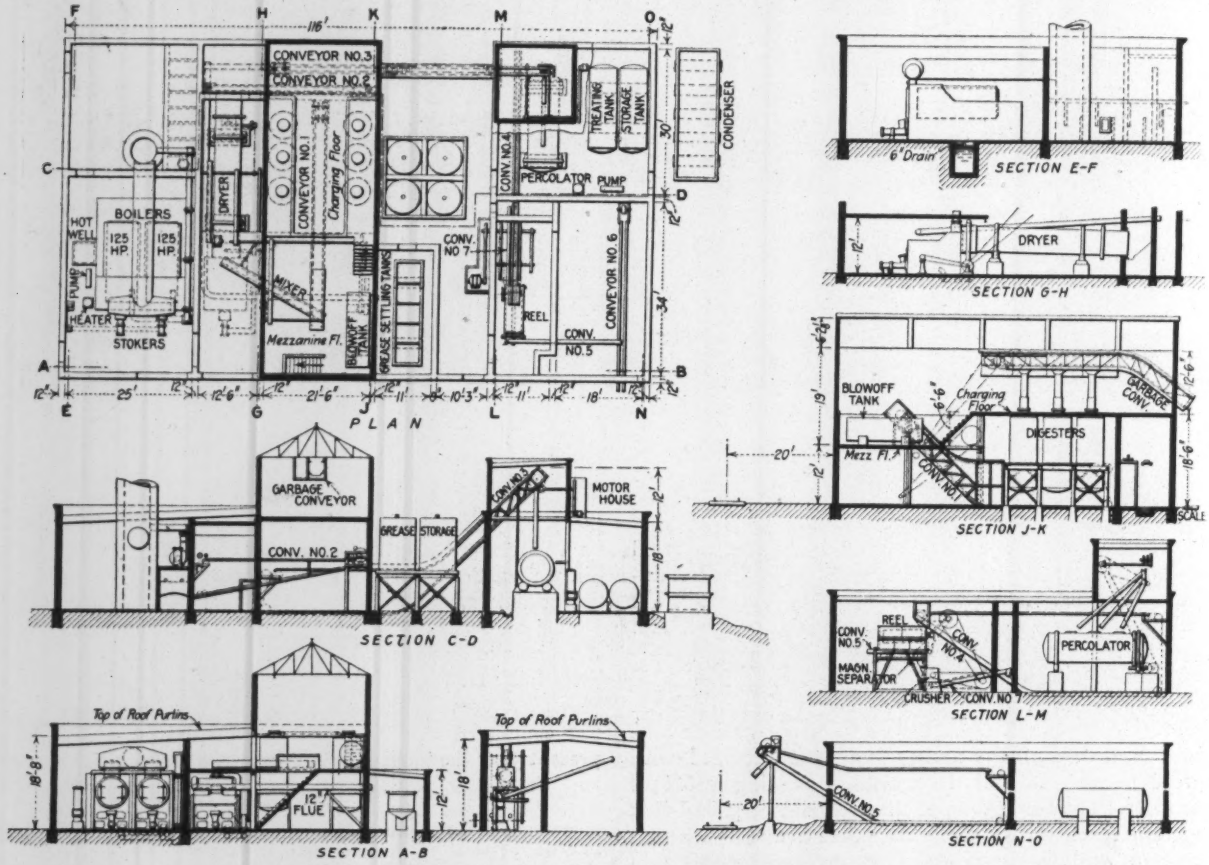


Fig. 1. Plan and Sections of Schenectady Garbage-Reduction Works

*Assistant Engineer, C. O. Bartlett & Snow Co., 50 Church St., New York City.

After having been pressed, the tankage is raked out through a door near the bottom of the digester and placed directly onto Conveyor 1, which runs between the two rows of digesters. Conveyor 1 (see Fig. 1) discharges the tankage into a horizontal screw mixer, 16 ft. long, which breaks up the tankage and feeds it to the drier. Later on, when an evaporator is added to produce "stick" from the grease-freed digester water, the mixer will also serve to mix the stick with the tankage before the latter is fed to the drier.

The drier is a single-shell direct-heat rotary machine. The furnace, which is located in proximity to the boiler furnaces, is equipped with an underfeed stoker. The blower which furnishes the air for the drier furnace takes its air from the room, thus consuming any foul air which may be present. The exhaust gases from the drier are also put through the scrubber, and such as remain may be passed through the boiler furnace, with the cooking vapors, or they may be passed directly into the stack.

After the tankage has been dried, it is taken by Conveyor 2 to a temporary storage room, where it is inspected so that no fire or sparks may be carried into the percolator room.

It is then taken by Conveyor 3 and discharged directly into a rotary percolator, having a normal capacity of six tons of tankage per charge. Fig. 3 shows half of the percolator room.

After the percolator has been filled with dry tankage, it is sealed and the tankage is washed with naphtha in order to remove the remaining grease, three or four washings being generally sufficient. The naphtha, which carries the grease, is passed to a treating tank, or still, where the naphtha is vaporized. This naphtha vapor passes through a surface condensor, after which it flows to the naphtha storage tanks for re-use. The grease which remains in the treating tank is treated so as to remove nearly all the moisture, and is then pumped to the grease storage tanks, located in the courtyard, being ready for market.

After the last wash has been withdrawn from the percolator, a certain amount of naphtha is still held in suspension by the tankage. This residue is vaporized by allowing live steam to pass through the tankage. The vapors are passed through the condenser, and the naphtha, after having been separated from the water (condensed steam), flows to the naphtha storage tanks.

After all of the naphtha has been driven off, as is determined by sampling the liquid flowing through the condenser, no more steam is applied. There is, however, a slight loss of naphtha, amounting to about three gallons per ton of tankage

The degreased tankage is dumped from the percolator onto the floor. It is then loaded onto Conveyor 4, which delivers it to a rotary screen, equipped with four-mesh wire cloth. The screened tankage is conveyed to the storage room by Conveyor 5, while the tailings are discharged onto a magnetic separator of the belt type, which removes all magnetic substances. The remaining tailings, which consist in the main of bone, broken crockery, wood and rags, are discharged directly into a Gardner crusher

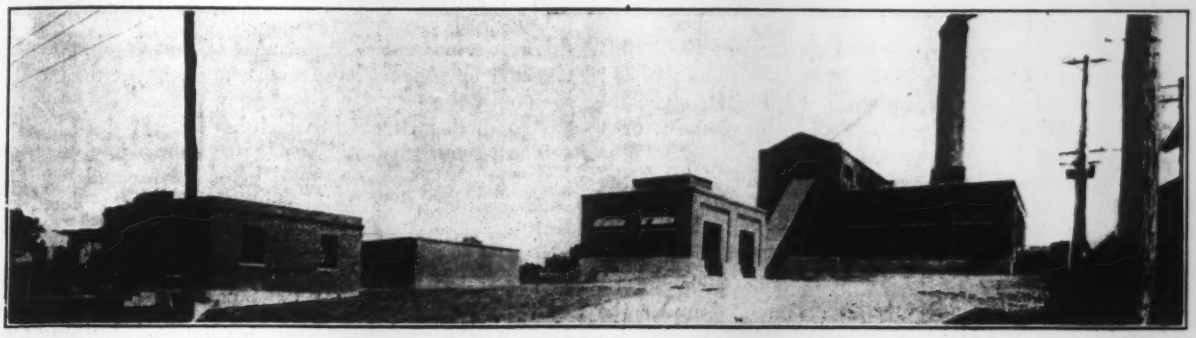


FIG. 2. MUNICIPALLY OWNED GARBAGE-REDUCTION WORKS, SCHENECTADY, N. Y.
(From left to right the buildings are: Office, gasoline storage, garbage-receiving and main reduction building)

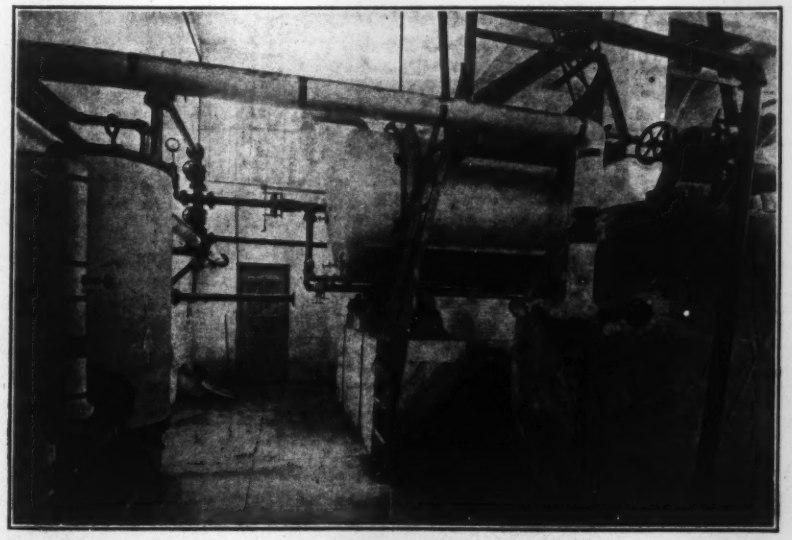


FIG. 3. PERCOLATOR ROOM, SCHENECTADY GARBAGE-REDUCTION WORKS
(Naphtha heater on the left, percolator in the center and naphtha-recovery tank on the right)

and are finely crushed. These crushed tailings are discharged onto Conveyor 7, which in turn discharges them onto Conveyor 4, from which they are taken through the screen again and into the storage room. When sufficient finished tankage has accumulated it is loaded directly into box cars for shipment by means of Conveyor 6.

The buildings are all constructed with brick walls and reinforced-concrete foundations, floors and interior columns. The office building is provided with shower baths for the men, and has a platform scale adjoining it, whereby the amount of garbage handled may be accurately determined. The approximate dimensions of the building, in plan, are: Office, 24x33 ft.; gasoline storage, 24x37 ft.; receiving, 24x36 ft.; main, 68x118 ft. The lot on which the buildings are located is 150x260 ft., or a little less than an acre in area.

The boiler room is located at the extreme right of the main reduction building, and is equipped with two 125-hp. return-tubular boilers, fired by means of underfeed stokers. The power required for driving the various conveyors and other machinery is supplied by electric motors.

Construction of the plant was commenced under the supervision of former City Engineer W. Thomas Wooley and was completed under the supervision of Olin C. Landreth, who succeeded Mr. Wooley. The plant is being operated by the Public Works Department through the direction of Deputy Commissioner W. W. Chadsey.

All of the machinery for this plant was furnished by the C. O. Bartlett & Snow Co., of Cleveland, Ohio, through its Eastern office, 50 Church St., New York.

Training and Advancement of City Managers

By Kenyon Riddle*

At the Conference of City Managers held in Springfield, Ohio, in December, 1914, the proper course to follow in order to fit oneself for the new field in city management, and then the procedure necessary to get a position as manager, were discussed. At that time I took the darkest side, so that I might draw out from others the favorable side of the argument. Most of the city managers agreed that advancement was assured for the managers who had the proper education and who were already in the field. They laid particular stress on actual experience, saying that this was of primary importance.

After serving for two years as city manager, I should most emphatically say that experience is of first importance, and that any city about to hire a manager should pay particular attention to the applicants who have experience to their credit. If one has had experience, the investigators may examine his title and past records. If he has shown that he is honest and capable, and qualifies for the particular position in mind, then these investigators are in a position to give a well-founded decision on the matter.

Education for the position of city manager, most will agree, should be along the general lines of engineering, with courses in executive and administrative training. After this education the would-be manager must get into the field in order to gain practical knowledge. But how? Some say that he should seek work in a city which is under the manager plan; others urge that he should try for a position as manager of a small town.

If the first course were to be followed, then, after completing his education, the aspirant might seek a position as rodman or instrument man in a city engineering department. If successful, he would learn to perform those duties, and, granting that the city employs the merit system, he would finally be promoted to the office of city engineer. If he were to start with a minor position in some other department of the city, he might advance in like manner to the head of that particular department. Does this equip him to act as manager of that or of any other city? I should say not fully, because he would have to his credit the experience and knowledge of only the one particular department in which he had served.

The second suggestion as to the course to follow offers a much stronger argument in its favor and seems to be the solution. After the young man has completed the training suggested, he may get a position as manager of a small town. In a short time he could tell whether he possessed the requirements of a manager. And here I wish to say that it requires natural talent along certain lines to fill the office. No matter what one's training may be, nor what particular technical ability he may have, he must possess administrative and executive ability. The only way to find out whether he has these requirements is through experience, and if he has no natural ability along these lines he is wasting his time to follow the manager profession, and if he has traces of this natural ability, he may train and cultivate them through practice.

Suppose a city were seeking a man as manager. Who is best qualified and who may this city feel most justified in employing? I should say the man who has been manager of the smaller town rather than the man who has been connected with some particular department in the larger city. Some may say that the man who has been trained in the smaller town has not had sufficient experience in the complex social conditions of a city to manage and direct its several departments. I should reply that the executive work of any one of these departments is similar to that of any other department; that he has the guidance of a legislative body, composed of men who are familiar with the local conditions and whose duty it is to determine policies; and that he may appoint capable and experienced heads to each administrative department—so lack of experience in every department is no argument against the manager from a smaller city becoming a manager for a larger one.

The successful manager of the smaller town has proved that he does possess administrative and executive ability. He has learned the real work of a manager, which we all know is complicated because of the large and varied scope of functions to be performed.

The amateur manager who started in a department for the larger city may receive some experience in organizing forces, but he does not receive the training which the person who starts in the smaller town may receive. The latter person not only directly organizes forces, but he is also the channel through which the plans and programs of all departments pass, and he reorganizes, groups and culls these plans so as to meet the general needs of the entire city. His experience is varied and includes all of the functions of a municipality and not merely a part.

The thing that seems most discouraging to the person in the smaller town is his *isolation*. Towns are not con-

*City Engineer-Manager, Abilene, Kan.

nected or linked together in any way. If they were, the larger towns would seek as their managers the men who had proved themselves capable in the smaller towns.

The idea of larger towns looking to smaller ones for their managers would put the new profession on a merit-system basis. Managers would have this prospective promotion as an inducement and incentive to do the best work they knew how. They would strive for results creditable to the profession.

It can safely be said that the essential duties of a manager are the same in the larger city that they are in the smaller one, except on a larger scale. A manager in passing from a small city to one ten times as large would multiply his customary functions by ten.

Engineers have not been given the recognition in public affairs that they deserve. It has been their fault to a large measure, for they have been too technical, too much consumed in the theory of engineering, and have neglected their position in public life. An engineer need not be a politician in the common sense of the word, but to command the position he deserves he must be a factor in public affairs. When he realizes this, more engineers will be found on commissions, in the legislature, etc.

If the men who have gone into the manager profession do not give due consideration to the necessary procedure for promotion, and do not educate the people to the correct procedure for securing managers, then managers will fall into the rut being followed by so many engineers.

Let us adjust the manager game while it is young, so that a man to qualify need not be a rank politician. The idea of the larger cities looking to the smaller ones for good material for a manager seems like a business proposition, of benefit to both the cities and the managers. Promotion for professional men is a common practice. It is the method employed by the cities of Germany in securing burgomasters or mayor-managers, under whom municipal government has become noted the world over for its efficiency.

Railway Mowing and Weed-Cutting Machines

The application of machinery to the slow and tedious work of cutting grass and weeds along railway tracks has been suggested at various times. A home-made contri-

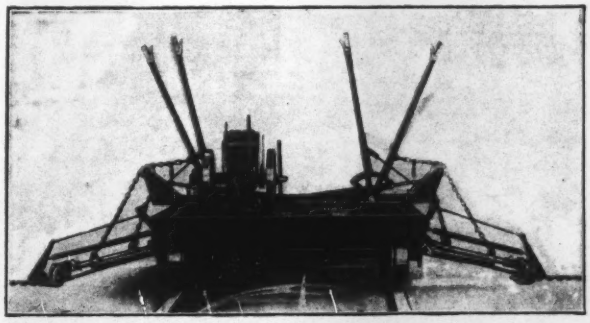


FIG. 1. MACHINE FOR MOWING GRASS AND WEEDS ALONG RAILWAY TRACK

vance for this work, described in ENGINEERING NEWS, Dec. 10, 1914, consisted of a push-car fitted with a 2½-hp. gasoline engine and the cutter from a farm mowing machine.

A machine of a similar type, developed on commercial lines and now being put on the market, is shown in Fig. 1. This is intended for mowing grass and weeds outside of the weed line. On each side of the gasoline car is a hinged frame carrying a cutter bar which will mow a 6-ft. swath. The frame extends over the ballast slope and the cutters can be set independently at any angle, to follow the slope of the ground. For branch lines, where the growth is heavy and the section forces are small, a third cutter bar can be carried in front of the car to cut grass and weeds between the rails. For traveling, the cutters are raised and the frames swung inboard. The car can run at about 3 miles per hour when cutting, or 15 when traveling.

A machine of a different type, fitted with revolving disk cutters, has also been introduced and is intended for digging out the weeds between the ends of the ties and

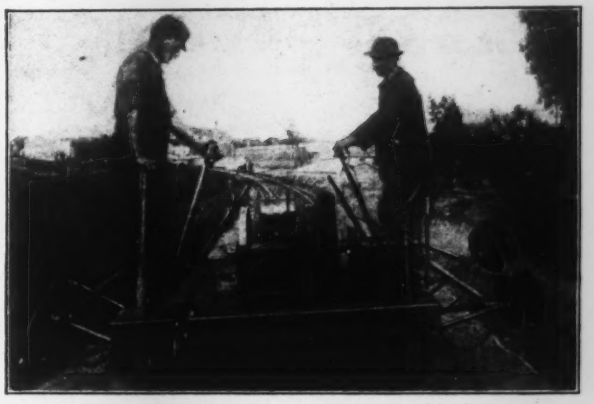


FIG. 2. MACHINE FOR DIGGING OUT GRASS AND WEEDS ADJACENT TO THE BALLAST SLOPE

the weed line. As shown in Fig. 2, this car has on each side a pair of revolving shafts carrying a pair of disks. These cut four furrows on either side of the track, like a plow. Each shaft is fitted with a brace and can be raised or lowered by means of a hand lever. The lever has a quadrant and latch so that the shaft can be held in any desired position. The car is equipped with a gasoline engine of 5 hp., with sprocket-chain gear for propelling the car and driving the cutter shafts. It can work at a speed of 2 to 4 miles per hour.

Both of these railway mowing and weed-cutting machines were designed by men in railway service and are being built by the Fairmont Gas Engine & Railway Motor Car Co., of Fairmont, Minn.

Mud apd Salts in Western Rivers—The Colorado River discharges during an average year into the Gulf of California 338,000,000 tons of mud and silt as suspended matter. In addition to this the dissolved substances in the water include 4,550,000 tons of sodium chloride, 3,740,000 tons of Glauber's salts; 4,000,000 tons of lime; 2,400,000 tons of gypsum; and 4,800,000 tons of Epsom salts. Other streams in the country contain dissolved salts in greater concentration—for example, the Elm Fork of Red River, in Oklahoma, discharges nearly 1,300,000 tons of common salt annually. The discharge of salt from the Colorado is equal to 20 tons annually to each square mile drained by the river, but the salt in Elm Fork of Red River is equal to 1680 tons per square mile of area drained. Elm Fork also discharges annually 177,000 tons of magnesium chloride, 168,000 tons of Epsom salts, 690,000 tons of gypsum, and 54,000 tons of lime.—"U. S. Geological Survey Bulletin."

Municipal Wharves and Sheds at Los Angeles

In the development of the harbor facilities at Los Angeles, Calif., the city has now two pieces of work under construction—(1) a timber wharf and shed on Mormon Island channel (or slip) in the inner harbor; (2) a concrete wharf and steel shed on the east side of the East Channel (or slip) in the outer harbor. The work was done under the direction of the Harbor Department: Homer Hamlin, Harbor Engineer; S. D. Jubb, Assistant Harbor Engineer.

Timber Wharf and Shed

These structures (Pier A, Shed 1) are typical of all the work on the Inner Harbor development. The completed portion is shown in Fig. 1, while the design is shown in the upper drawing of Fig. 3. The wharf is of creosoted piling, with a timber deck and bulkhead, and carries a track along the outer edge. The shed is 100 ft. wide and 600 ft. long (now being extended to 1000 ft. total length), with timber frame and roof trusses, and sheathed with asbestos-protected corrugated metal. It was opened for use in 1914, and is the first completed unit under the control of the municipal authorities. It is used by the American-Hawaiian Steamship Co. A similar shed, 510 ft. long, was built on a wharf of the same type at Water St.

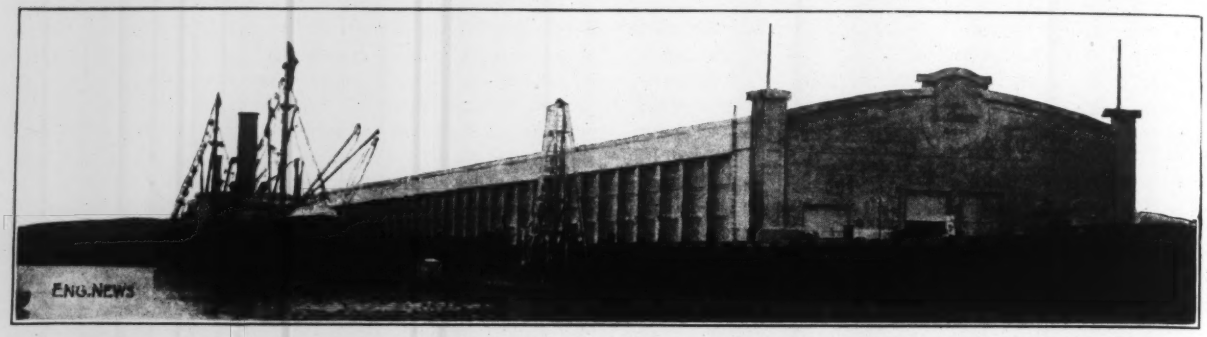


Fig. 1. Municipal Wharf and Shed in the Inner Harbor at Los Angeles, Calif.

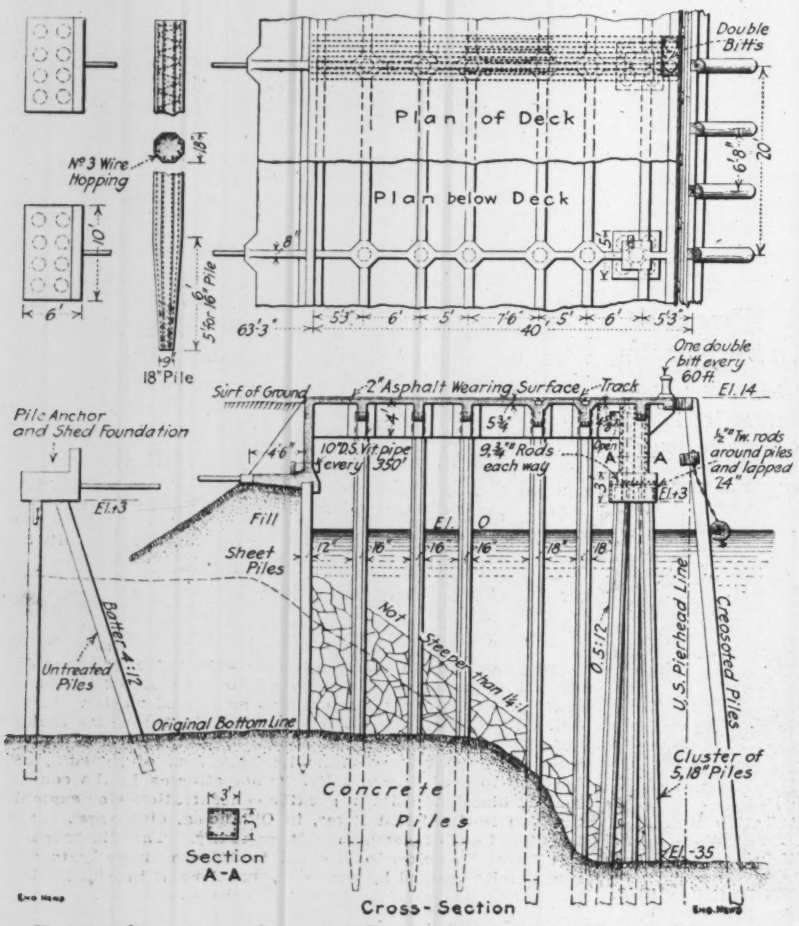


Fig. 2. Details of Concrete Part of the Outer Harbor Wharf at Los Angeles, Calif.

Concrete Wharf and Steel Shed

One of the first sections of the Outer Harbor development will be a pier (or dock) 650 ft. wide and 4000 ft. long, with the main ship channel on the east side and the East Channel on the other side. This latter channel is a slip 350 ft. wide. The pier will be a solid fill, and the wharf now under construction (2500 ft.) forms the east side of the East Channel. Fig. 4 shows the wharf under construction, with the solid-fill pier at the left. Upon the wharf is being built a shed 100 ft. wide and 1800 ft. long. The general design of wharf and shed is shown in Fig. 2, while Fig. 3 shows further details.

The pile bents are 20 ft. apart, each bent having five single piles (spaced as shown) and an outer cluster of five piles. This cluster has a cap block 5 ft. square, supporting a pedestal 3 ft. square. Each bent is capped with a cross-girder, extending as a cantilever at the outer end to support the overhanging part of the deck. Between the cross-girders are six stringers, two of which (under the railway track) are heavier than the others. The concrete deck is 4⅝ in. thick, recessed for the track rails, each rail being laid on a timber stringer. Upon the concrete is a 2-in. wearing surface of asphalt.

The fill is retained by a bulkhead composed of 12x12-in. sheet piling, surmounted by a concrete back wall, with broad footing and counterforts. At these counterforts are attached tie-bars extending back to anchor blocks which form the foundation pedestals of the shed (Fig. 2).

The face of the wharf is protected by a timber fender. This has inclined piles of creosoted timber, connected by waling pieces and struts, and having their heads fitted to fender timbers on the edge of the concrete deck.

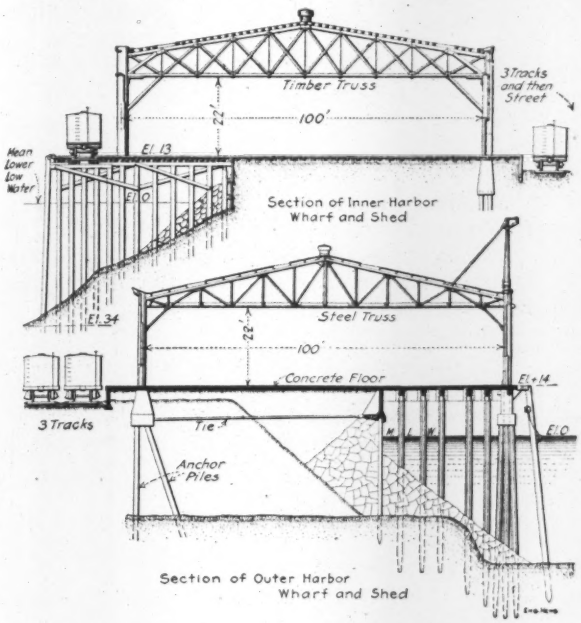


FIG. 3. CROSS-SECTIONS OF MUNICIPAL WHARVES AND SHEDS AT LOS ANGELES, CALIF.

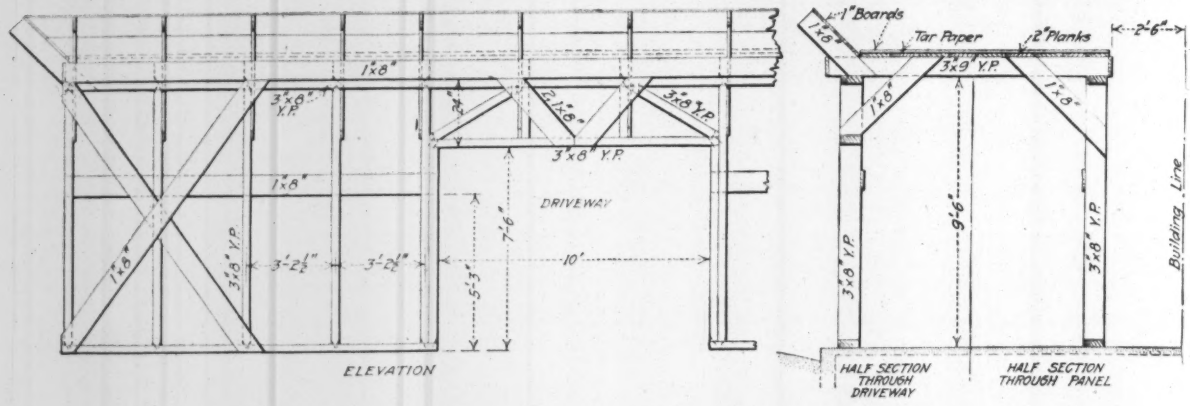
Decreased Mineral Production in Canada in 1914—The mineral production in Canada in 1914 is valued at $128,475,499, as against $145,634,812 in 1913, a decrease of 11.8%, according to the preliminary report just published by the Canadian Department of Mines. There was a gradual falling off in nearly all mine products, the notable exceptions being pyrites, salt and natural gas. The general decrease is, of course, explained largely by the conditions resulting from the European war. The reduction is most pronounced in the case of coal, asbestos and gypsum, and in products such as cement, clay products and lime. Iron-ore shipments amounted to 244,854 tons, valued at $542,041, as against 307,634 tons in 1913. Of the 1914 production, 135,451 tons were exported, of which 60,410 entered the United States. Imports of iron ore in 1914 were, according to customs records, 1,147,108 tons. The total production of pig iron was 783,164 tons, a falling off of 345,803 tons. Of marketable coal, the total output was about 13.5 million tons as against 15 million in 1913. The exports of coal were 1,423,126 tons, while the imports were 14,721,057. In the crude oils there was an increased importation, while the imports decreased for refined illuminating oils, lubricating oils and gasoline. The annual output of crude oil has been decreasing in Canada for the past seven years. There was a heavy falling off in the production of building materials. This situation, while aggravated by the war, is alleged to be due in large part to overdevelopment and extravagant land speculation. The total quantity of cement, including slag and natural cement, made in 1914 was 8,727,269 bbl. of 350 lb. each, about 2% less than in the preceding year. Imports amounted to 98,022 bbl., a drop of 61.5%.

FIG. 4. CONSTRUCTION OF MUNICIPAL CONCRETE WHARF, FORMING THE SIDE OF A SOLID-FILL DOCK IN THE OUTER HARBOR AT LOS ANGELES, CALIF.

Field and Office

Standard Sidewalk-Protection Platforms

The Bureau of Highways of Philadelphia, Penn., under Wm. H. Connell, Chief of Bureau, has adopted a standard sidewalk-protection platform of the design shown in the accompanying illustration to which all building contractors must conform. This platform is designed for a pavement 13 ft. in width or under, to carry a live-load of 200 lb. per sq.ft. If the load is larger than this, the cross-sections of or the number of posts and joists are doubled. For fastening the 1-in. boards 10d. nails are specified; for 2-in. planks, 20d., and for 3-in., 10d. All posts are 3x8-in. timber, toenailed top and bottom. The joists for platforms must be, 13 to 14 ft., 3x10's; 14 to 16 ft., 3x12's; 16 to 20 ft., two 3x12's; 20 to 22 ft., three 3x12's. An unusual feature in the design is the double floor and waterproofing layer of tar paper. The platform structure must be painted a dark green, and no bill-posting or display of signs and advertisements is permitted.



STANDARD SIDEWALK-PROTECTION PLATFORMS OF PHILADELPHIA, PENN.

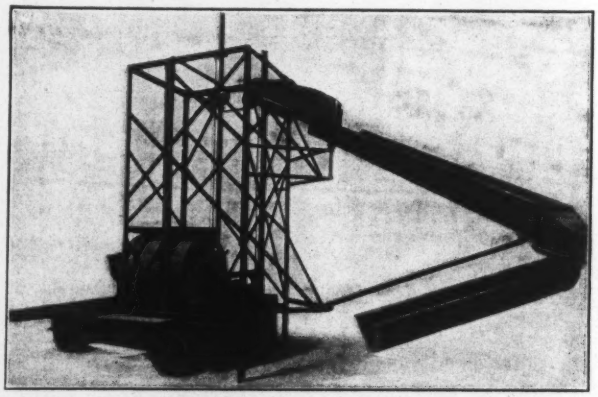
Portable Concrete Mixer with Elevator Tower

A new portable mixer for paving and general work embodies the original feature of a short tower for handling the concrete. In most paving mixers the concrete is delivered from the drum directly into a chute or to a dump bucket traveling on a horizontal boom. The application of the elevator tower, with its greater height of discharge, gives a greater reach or horizontal working radius, besides making the machine adaptable to work of considerable height.

The accompanying view shows the steel-frame truck, with mixer, tower, elevator bucket, hopper, chutes and folding platform, but without the engine or motor equipment. The machine is built by A. J. Cropp & Co., 1840 Carroll Ave., Chicago, Ill.

The tower is made about 11 ft. high, so as to pass under bridges and trolley wires, but arrangements can be made for attaching to this a hinged second section of 12 or 15 ft. held by guys. The chute is made in two sections, with swivel connections, so that concrete can be delivered within a sweep of 250° and a radius of 30 to 35 ft. The weight of the machine with a mixer of 10-cu.ft. capacity and including tower and traction equipment complete is about 4000 lb.

At the charging side the head of the drum is cut away so as to leave only a narrow flange, thus making it easy to dump the charge from a wheelbarrow. The drum has a recharging pocket to prevent spilling of the concrete, and the discharge can be regulated to any desired amount, while the entire batch can be dumped in two revolutions.



PORTABLE CONCRETE-MIXING OUTFIT WITH ELEVATOR TOWER

A special drum used on the larger mixing outfits has two compartments, one for charging and the second for mixing. The claim for this is that it reduces the time lost in waiting to charge the mixer and enables the work to be done with fewer men without reduction in speed or capacity of output.

Protecting Valuable River Lands in California

In the hops and prune country of California, land often reaches a value of $1000 per acre. In such districts, bordering on rivers, the protection of the banks against erosion is a problem worthy of a considerable expenditure of money. The accompanying view and

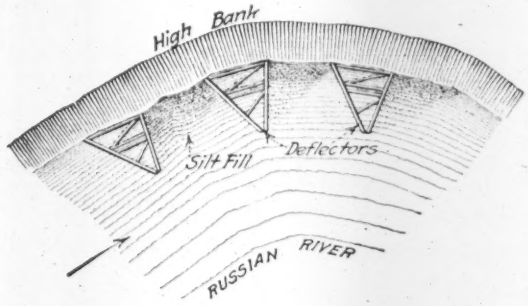


FIG. 1. ARRANGEMENT OF CURRENT DEFLECTORS IN RUSSIAN RIVER

sketch show the use on the Russian River in Sonoma County of a current deflector which has proved quite successful for such protection on various rivers in the district.

The device, which is known as the Dean river-current deflector, consists essentially of a number of timber frames of triangular plan anchored to project from the bank into the river. By this means the current is diverted from the bank, which is protected thereby, and at the same time a silt or sand fill is built up back of

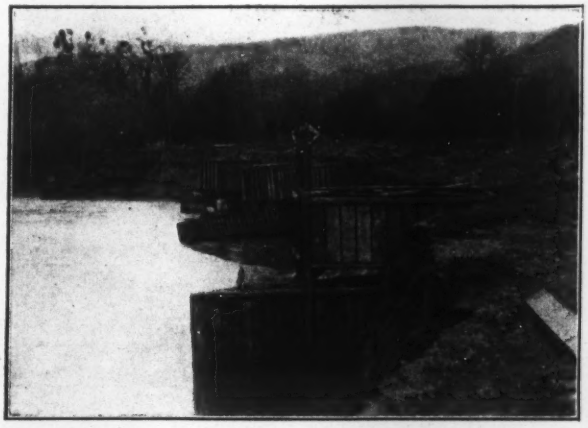


FIG. 2. DEAN CURRENT DEFLECTORS IN PLACE ON RUSSIAN RIVER

each deflector unit, extending practically to the next deflector. In some cases where these have been used, they have not only held the bank from erosion, but have built up spots where erosion had already taken place.

The view in Fig. 2 shows a series of double-deck deflectors—all placed, tied and weighted. In addition to the wire anchors to the bank, the unit is held by anchors made of barrels filled with concrete. One or two of these are placed on top of the unit, and the others are dropped upstream and fastened to the structure with cables.—E. F. COMSTOCK, Santa Rosa, Calif.

High Coefficients of Roughness for Natural River Channels

The publication of Mr. Fish's interesting and useful chart for the solution of Kutter-formula problems (Apr. 15, 1915) prompts me to make one or two comments on slope calculations for natural river channels, since I have advised that all such diagrams should cover coefficients of roughness up to 0.060 or 0.100. These values occur much more commonly than might be at first supposed.

I have had occasion to determine the coefficients of roughness from actual experiments for a number of large natural river channels, including the Mohawk and Black Rivers in New York state, covering all stages of the stream from low water to extreme floods. I have invariably found in such instances that the actual coefficient of roughness is by no means constant for a given reach of the stream at different stages, but that it nearly always decreases as the stage of the stream increases. I find also that this is not because the roughness of the banks is usually greater than that of the bed of the stream, as the reverse is frequently true. The real reason is that in deriving the coefficients of roughness for a natural river channel, the actual areas of cross-section as determined by soundings are used. In nearly all such streams there are pockets in the stream bed, the cross-sections of which are included, but in which there is very little actual velocity, especially at low stages of the stream. The result is that the calculated coefficients of roughness are derived for larger areas than the effective areas of cross-section. Coefficients of roughness so derived will give true velocities when working from these same cross-sections, because the error due to using a cross-section greater than the effective cross-section of actual flow is by this method thrown into the coefficient of roughness. As the stage of the stream increases, the percentage relation between non-effective and effective cross-sectional area is reduced; the coefficient of roughness also decreases as the stage increases, gradually approaching that for a condition where the entire cross-sectional area is effective.

For very rough streams during low water only a part of the actual fall between any two given points may be effective in producing velocity. One not infrequently finds water flowing to a depth of say 2 ft. on the bottom of a broad river in such a manner that in one-half of the width there is a smooth swift current and in the other half a series of slight falls and ripples, the average velocity being very much less than that in the first half. For this reason also, the coefficient of roughness as deduced from actual observations of slope is likely to be very much higher for low stages than for higher stages of the stream.

Mr. Fish gives a value 0.035 to the coefficient of roughness for canals and rivers in one of his examples; this would apply as a rule only for "relatively high" or bank-full stages of channels in bad order. Natural channels which will have this coefficient for bank-full stages are very likely to have a coefficient of 0.045 to 0.060 or even higher for low stages of the same stream.

Mr. Fish suggests the use of the mean depth as equal to the hydraulic radius for rivers. There doesn't seem to be any uniformity of practice among engineers as to methods of determining the hydraulic radius from

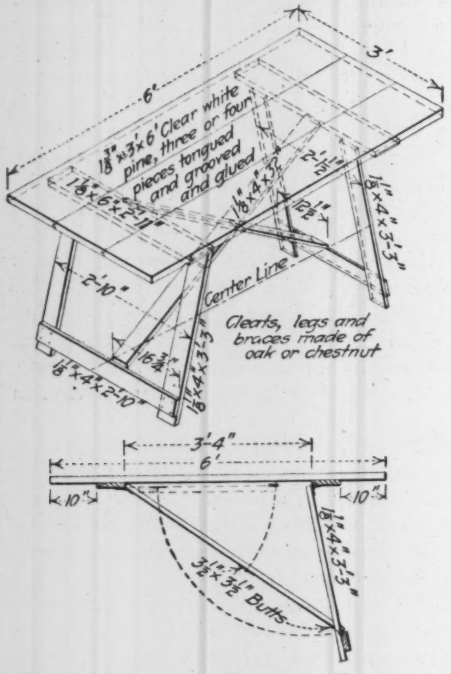
plotted cross-sections of rivers. The method suggested by Mr. Fish in its effect is equivalent to dividing the area by the width, the width being assumed equal to the wetted perimeter. The wetted perimeter is invariably greater than the width and consequently Mr. Fish's method gives too large a hydraulic radius.

I have extensively used a method taking the wetted perimeter as equal to the surface width plus twice the mean depth. This scheme is correct for any rectangular section. In view of the fact that, owing to irregularities of the stream bed, the wetted perimeter is almost invariably greater than the actual measured width across the bottom plus the length of side slopes, it appears that this method will give very nearly correct results for all large river cross-sections—although theoretically it gives a hydraulic radius somewhat too small in the case of a trapezoidal or triangular cross-section.

Another method which I have seen used consists in measuring the wetted perimeter by running an opisometer over the plotted cross-section. This method is sometimes used even where the vertical scale is say 10 ft. per in. and the horizontal scale 20 ft. per in. It invariably leads to error in both the wetted perimeter and hydraulic radius if the vertical and horizontal scales of the cross-section are not the same.—ROBERT E. HORTON, Albany, N. Y.

A Field Drafting Table

Engineering operations which require temporary offices require also portable drafting boards or tables. A drafting board resting on horses or trestles is unsatisfactory, since it lacks stability, and the trestles take up valuable space when packed in a vehicle. The accompanying sketch shows a convenient drafting table patterned after a folding table† of older design. This one, however, is steadier when open and more compact when closed. It has been tried out long enough to demonstrate its durability.—WALTER LORING WEBB, Philadelphia, Penn.



A DURABLE FOLDING DRAFTING-TABLE FOR FIELD OFFICES

†Described by Fred Lavis in a paper entitled "Methods of Location on the Choctaw, Oklahoma & Gulf R.R.," Vol. LIV of the "Transactions" of the American Society of Civil Engineers.

Subdrainage of Earth Roads

Deep side ditches for the drainage of earth roads are objectionable, and especially so in these days when the horse-drawn country vehicle must keep well on the side of the road to avoid recklessly driven motor cars. Under such conditions subdrains are justified, even in locations

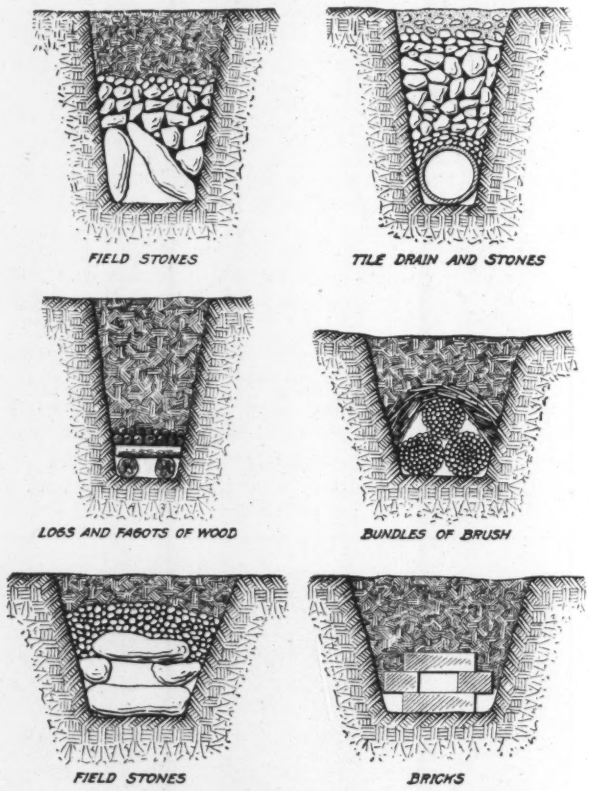


FIG. 1. TYPES OF SUBDRAINS FOR EARTH ROADS

which are not noticeably damp or swampy. Moreover, it is common knowledge that there are many roads which would be permanently improved by some form of subsurface drainage where the average highway engineer would not consider such drainage absolutely essential.

Subdraining earth roads is neither difficult nor expensive, but takes judgment and horse sense. Surface water should not be allowed to run into these drains, especially on flat grades, or they will soon become plugged up. The drains should have a fall of not less than 0.3 ft. per 100 ft., and should have outlets into side ditches or adjacent fields and streams as often as practicable. When this is impossible the outlet may be into diverging blind drains. In the construction of subdrains care should be taken to have a continuous and even grade, and to prevent sand and soft earth from being carried in by the first storm which comes after backfilling the trench. Low points where sand and mud will collect must be avoided. Some inexpensive types of subdrain are shown in Fig. 1.

For laying these subdrains Hiram Donkin, Road Commissioner and Provincial Engineer of Nova Scotia, recommends the use of a simple home-made plumb-line level (Fig. 2). To graduate this instrument to establish a 5% grade, for example, bring the instrument to a level along the line of the drain by the use of the spirit level F; mark the center ab; then raise the updrain end through a distance one-twentieth of the length of the base line AC. The plumb line will cross the board DE in some line away

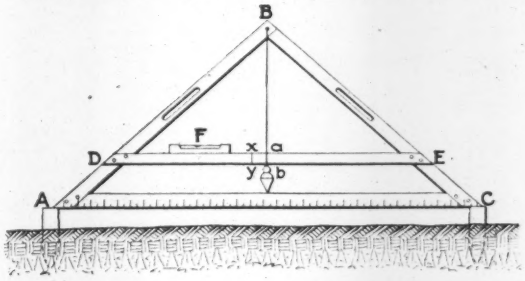


FIG. 2. SIMPLE LEVELING INSTRUMENT FOR ROAD DRAINAGE

from the center ab. Mark this crossing xy. The same grade can then be found at any point in the drain by leveling till the plumb line crosses at ab, and then raising the updrain end (or lowering the other end) till the plumb line crosses again at xy. By the use of such a simple instrument an intelligent road foreman can do as efficient work for the purpose as an engineer with a wye-level.

Rolling Wet Concrete for Roads

The consolidation of wet concrete by a roller which serves also to give the desired crown to the roadway is a new feature which has been introduced by Henry L. Bowlby, State Highway Engineer of Oregon, who is the inventor of the machine.

A steel frame extends across the road and is supported at each end by a pair of grooved wheels which ride on the side forms. These forms are substantially built and adjusted carefully to grade. Parallel with

POWER ROLLER FOR CONSOLIDATING CONCRETE PAVING

the sills of this frame is a cast-iron roller long enough to cover the full width of the paved roadway and having its face concave to give the required crown. Cross-timbers resting on the sills carry a gasoline motor and a countershaft, the two wheels at one end of the frame being driven from the countershaft by chains and sprocket wheels. The machine weighs about 1½ tons and is said to be superior to and quicker than hand tamping in making the concrete dense and free from voids.

With two-course paving the concrete for the base is mixed moderately dry and spread with hoes. When this has been deposited for a distance of about 20 ft., the roller makes one trip over and back. Then a wetter mixture is deposited for the 1½-in. surface and at once rolled, a light wave of concrete being carried in front of the roller. The specifications for one-course paving require the concrete to be rolled at least four times, and when moving from the mixer on the last trip, the roller must be raised to clear the concrete. After this, the surface is to be smoothed with a template and finished with wood floats. In actual work, the use of the template is sometimes omitted.

Simple and Efficient Recording Gage for Weir Measurements

A recording gage of very simple construction and particularly suitable for the rough surroundings usually attendant on the measurement of sewage flow by weirs has been in use for the last dozen years by the Massa-

FIG. 1. SIMPLE RECORDING GAGE FOR MEASURING SEWAGE FLOW OVER WEIR

chusetts State Board of Health (now State Department of Health). The accompanying view (Fig. 1) shows a gage under typical conditions. Fig. 2 shows the elements of the gage and Fig. 3 gives drawings of all the details. The gage is not patented and is unpatentable, so any one may build one from these plans.

The gage consists of a copper float, to which a rod and pencil are attached, and a cylindrical drum, which is caused to revolve by an ordinary 8-day clock mechanism. The float rod engages in two brackets which are provided with roller bearings. The paper diagram is fastened upon the drum by pin points at the top and bottom and by rubber bands. The elevation of the starting point in relation to the crest of the weir is obtained by means of a hook gage. Thus the actual head on the

weir is shown on the diagram. The gage is very sensitive and operates under conditions that would often cause interference with a more elaborate gage. The cost of this gage is only about $25 or $30, which includes $4 for the 8-day clock mechanism.

The following is a list of materials and the specifications necessary to assure a satisfactory job:

WOOD MATERIALS—1 base board, 11x8x2 in.; 1 back board, 18½x8-in. bottom, 3½-in. top by ⅞ in.; 1 top board, 6x3½-in. back, 1¾-in. front by ⅞ in.; 2 box sides, 10½x2½x¼ in.; 1 box end, 8x2¾x¼ in.; 1 cypress strip, 7½x½x¼ in.; 1 cypress strip, 8x½x¼ in.; 1 cypress strip, 10½x½x½ in.; 1 cypress strip, 10½x4x¼ in.; 1 cypress strip, 10x1x¼ in.; 1 cypress cylinder, 12x7 in diameter.

The cypress cylinder is built up of small pieces of thoroughly seasoned cypress, turned on a steel spindle and bored as shown on the drawing. The cylinder is thoroughly shellacked or varnished with a waterproof coating, both on the inside of the boring and on the outer surface. A cypress guide for the float rod 3 ft. by 3 in. by 1 in., grooved and slotted as shown on the drawing, is also required.

SPECIFICATIONS—All woodwork is thoroughly seasoned cypress, straight-grained, clear and free from all knots, shakes and other imperfections. All parts are to be finished smooth and coated with at least three coats of waterproof shellac or varnish.

All work must correspond to specified dimensions, and all exposed surfaces and all surfaces requiring a smooth and even bearing, except on floats and float receivers, are to be smoothly finished. Brass screws of the proper size and length specified are to be furnished for all parts requiring them.

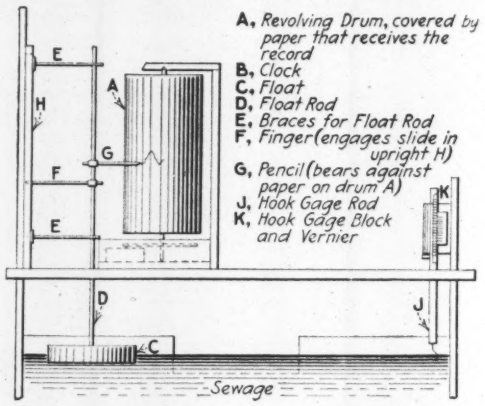

A, Revolving Drum, covered by paper that receives the record
B, Clock
C, Float
D, Float Rod
E, Braces for Float Rod
F, Finger (engages slide in upright H)
G, Pencil (bears against paper on drum A)
J, Hook Gage Rod
K, Hook Gage Block and Vernier
Sewage

FIG. 2. ASSEMBLY DRAWING OF GAGE

METAL MATERIALS—One double-spring engineer's clock-works, standard pattern, as made by Seth Thomas, Thomaston, Conn.; 1 brass unfinished spur gear, 7-in. pitch dia., ½-in. hole, 168 teeth, spoked pattern (Boston Gear Works No. 275).

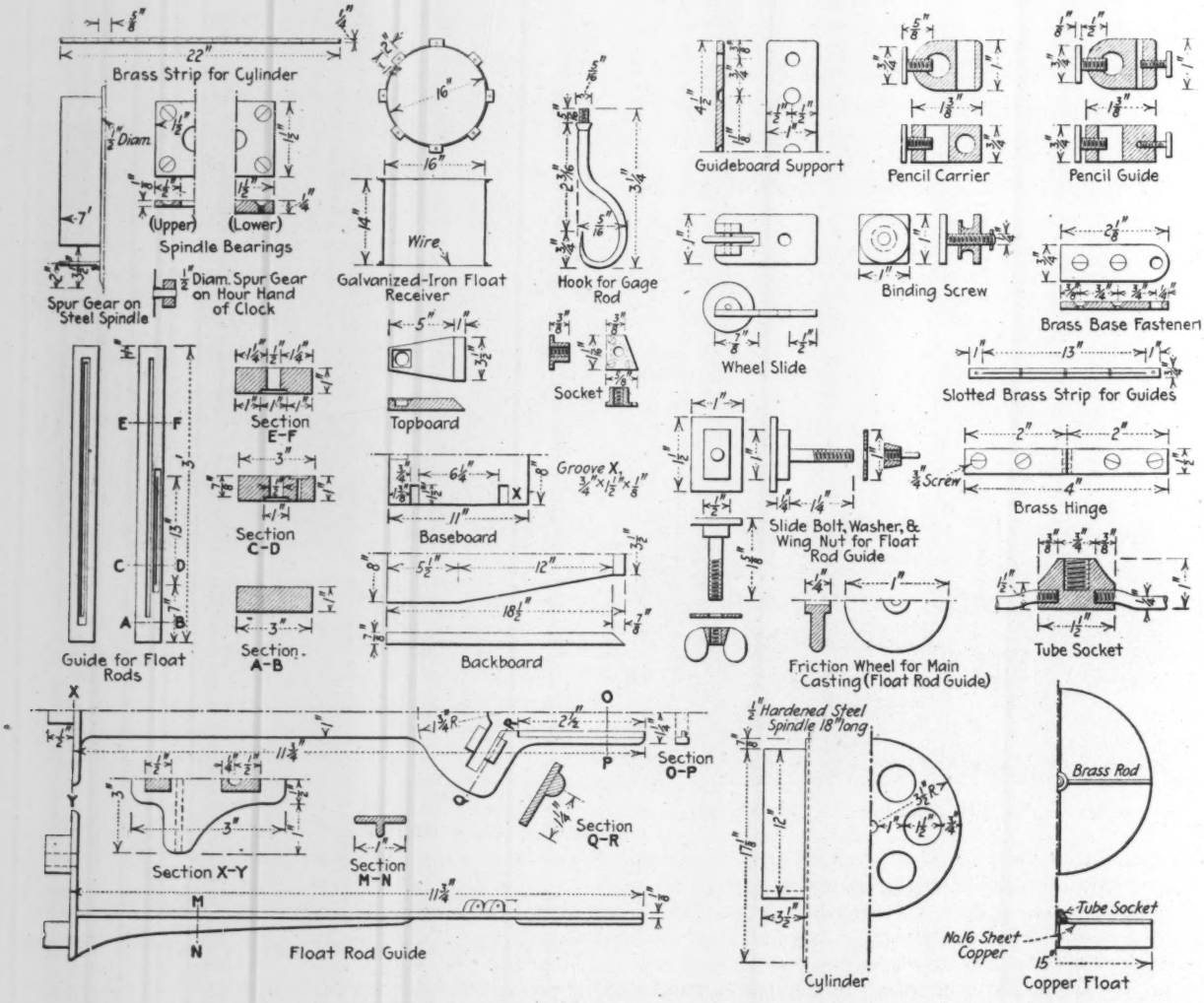


FIG. 3. DETAILS OF RECORDING GAGE USED BY THE MASSACHUSETTS STATE DEPARTMENT OF HEALTH

fastened on steel spindle, and spindle to be turned and beveled as shown on the drawing; 1 brass unfinished spur gear, plain pattern, ½-in. pitch dia., $\frac{3}{16}$-in. hole, 12 teeth (Boston Gear Works No. 254), fastened on hour hand of clock as specified; 1 brass lower spindle bearing—1½x1½x¼ in. as shown on the drawing, 1-in. wood screws; 1 brass upper spindle bearing—1½x1½x⅛ in. as shown on the drawing, 1-in. wood screws; 1 pair of brass hinges, with crews—½x4x⅛ in., as shown on the drawing, 1-in. wood screws; 2 two-inch brass 90° angles, with square corners, ⅞-in. wood screws; 5 brass base fasteners, 2⅛x⅜x⅛ in., as shown on the drawing, 1-in. wood screws; 1 brass strip, 22x¼x$\frac{1}{16}$ in., perforated at ends and between ends at a distance of about 1 in., with holes to receive ⅝-in. brass escutcheon pins No. 17 wire gage—escutcheon pins to be furnished by the contractor; 1 copper float, reinforced as shown in the drawing, copper sheet to be No. 16 gage; 1 brass float tube, medium weight brass piping, ⅛ in. dia., 4 ft. long, threaded with standard-pipe thread through a distance of ¾ in. at one end; 1 galvanized-iron float receiver, No. 16 sheet iron, 14 in. long, 16 in. dia., as shown in sketch, with wire netting at bottom; 2 float rod guides with friction wheels, and appurtenances as shown on drawing; 1 brass strip, 15x¾x⅛ in., with slot 13x⅛ in., as shown on drawing, ½-in. brass wood screws; 2 brass guide-board supports, 4½x1x⅛ in., as shown on the drawing; 1-in. brass wood screws; 1 brass pencil carrier, as shown in sketch; 1 brass pencil guide, as shown in sketch; 1 piece ⅛-in. hardened, stiff brass rod, 12 in. long; hooks for gage rods, with sockets, and ½-in. small wire, brass wood screws.

The Chief Engineer of the Massachusetts State Board of Health is X. H. Goodnough and the Assistant Engineer is R. M. Whittet, to whom we are indebted for the details of this gage.

A Compact Screening Plant

A specially compact plant for screening stone and gravel is made with telescoped revolving screens, so that three screens occupy the space ordinarily occupied by a single screen, while less shafting and a smaller structure are required. The screens are conical and are placed in opposite directions, all being connected to form one structure driven from one shaft. The construction is shown in the accompanying drawing.

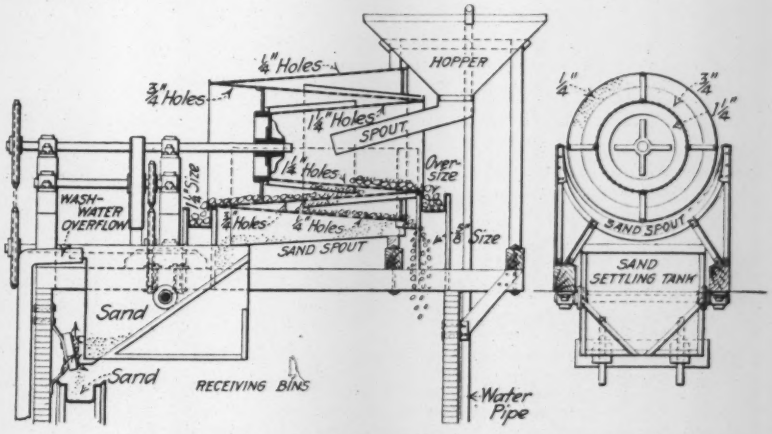
The material is delivered by a spout to the interior of the smallest or inner screen, which has 1¼-in. holes, and the oversize of this falls out from the end into a spout or conveyor which returns it to the crusher. The material passing through this first screen falls upon a conical apron attached to the screen and is delivered upon the surface of the higher end of the second screen, which has ¾-in. holes. The 1¼-in. material passes out at the large end of this screen and is caught by a chute or conveyor. The finer material which passes through the perforations falls into a conical apron and is delivered to the upper end of the third and outer screen, which has ¼-in. holes.

The ¾-in. material rolls out at the end of the screen, while the fine stuff which passes through the perforations falls into a trough or sand spout and goes to a settling tank or hopper. This hopper has an oscillating movement, causing the wet sand to flow out into another spout or conveyor. This machine is the invention of Charles Biesanz, of the Biesanz Stone Co., Winona, Minn., and is in use at that company's stone and gravel plant.

NOTES

Testing Buildings for Settlement During Subway Construction—In order to ascertain from time to time if there is any movement of buildings, elevated columns or other structures along the route as the result of subway work, permanent benchmarks are established on such structures. A good practice is to set all the marks at some even-numbered elevation so that when checking the elevation of the points it is unnecessary to have the original record in the field, as any other than an even numbered elevation indicates movement. A record of the elevations is kept on 8x11-in. sheets which give the plan of the building, a description of the benchmark, etc. Whenever levels are taken on a building a record is made on the sheet and the differences are noted. There is a general sheet for each building. A sheet of similar form is used for elevated-railway columns. In addition to fixing the elevation of some permanent mark on buildings and elevated-railway columns these structures are plumbed so that the movements due to construction can be detected. An auxiliary base-line is run close to the buildings and sights are taken with a transit to points on the top and bottom of the structure. In the case of buildings, marks are cut on the wall as near the roof and as near the sidewalk as possible, and sometimes at intermediate points, and a record made of the reading from these points to the auxiliary base-line. Movement of the building as a whole as well as any change in inclination can then be detected. In the case of elevated-railway columns, marks are cut at top and bottom and readings are taken to the auxiliary base-line, and also to a line at right angles to this line at each column, so that movement in any direction can be observed. These records are kept on 8x11-in. sheets similar to the ones for settlement levels. Prior to beginning construction work, an examination is made of each building which might be affected by the work. A report is made of the condition of each room of the building describing all the defects in the walls, ceilings and all ordinary conditions which might later be attributed to subway work, and in addition a similar record is made of the condition of the exterior, the cellar and the roof.—P. M. Entenmann, New York Public Service Commission, in "Public Service Record."

Sand Glasses for Timing Asphalt Mixing—At the Hastings, N. Y., plant of the Hastings Pavement Co., 1-min., 3-min. or 4-min. sand glasses of the time-honored hour-glass type are used to time the mixing of the asphalt-block composition. G. P. Hemstreet, Superintendent, states that clocks and watches have been tried, but nothing has proved so satisfactory as the old-time sand glass. This furnishes the suggestion that the same device might be employed in concrete mixing and a variety of other engineering work where short time intervals need to be measured in the simplest and easiest way.

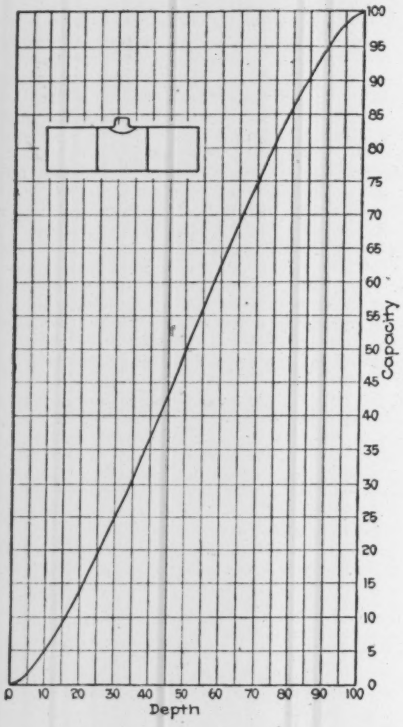


A Stone-and-Gravel Screening and Washing Plant with Telescoped and Concentric Conical Screens

Dynamite Fumes Kill Rodents—A simple and effective scheme for killing destructive small animals in their burrows has been discovered (according to the "Dupont Magazine") by Leonardo Ruiz, a rancher, of Ravenna, Calif. About 1½ or 2 in. of a 40% dynamite stick is wrapped in a cloth or paper and provided with a fuse but no detonator. One of these charges is stuck down into each hole and some loose

dirt packed around the fuse. There is (or should be) no explosion after lighting the fuse; the dynamite merely burns, filling the hole with dense poisonous fumes. The cost of materials is about 2c. per hole.

A Calibration Curve for Horizontal Cylindrical Tanks of any dimension, shown in the accompanying figure, has been developed by H. J. Elson, 325 Locust St., St. Louis, Mo. As the curve stands, it is plotted between percent. depth and percent. capacity. But it may be adapted for any particular tank by finding the total capacity in gallons (square of diameter in feet, multiplied by length in feet, multiplied by 47, divided by



CAPACITY CURVE FOR HORIZONTAL TANKS

8) and substituting gallons for percentages. The measuring stick in the tank used may be graduated into percentage of depth or feet and inches may be substituted on the scale by using the proper proportions of diameter. The curve is designed for square-ended tanks; for dished-end cylinders it is only approximate. Large-sized reproductions of the curve may be obtained from Mr. Elson or from the Universal Iron & Supply Co., tank makers, St. Louis, Mo.

Cost of Highway Surveys—The following information is from the 1914 report of the State Highway Engineer of Idaho. Ordinarily, the organization of survey parties was limited to about six men as follows:

	Per Month
Transitman, in charge of party	$125
Head Chainman	60
Rear Chainman	45
Levelman	75
Rodman	50
Teamster-Stakeman with team	75

The men and team were furnished subsistence in the field.

Except in timbered country where one or two axmen are absolutely necessary, and also a cook where the country is sparsely settled and where subsistence at towns and ranches could not be obtained, much of the work was done with a party of from four to six men. In average country such a party is expected to cover an average of from one to two miles per day, the amount being less in timbered and mountainous country and greatly increased in level open country. The record of some of the parties shows as high as eight miles per day. This, of course, was along present section-line roads where the progress depended upon how fast levels could be taken. In timbered country the progress depends largely upon how fast a line can be cut by the axmen with all hands busy. In rough timbered country, it is absolutely necessary for the chief of party to make reconnoissance of the country ahead of the work, and select the governing points through which to run the line.

For this reason and in order to economize as much as possible, considerable care had to be exercised in selecting men who were competent to fill the position above that for which they were employed, so that the work might proceed without interruption.

In most cases a highway survey cannot be carried along over rough country as rapidly as a railway survey, for the reason that there are more curves to avoid heavy cuts and fills.

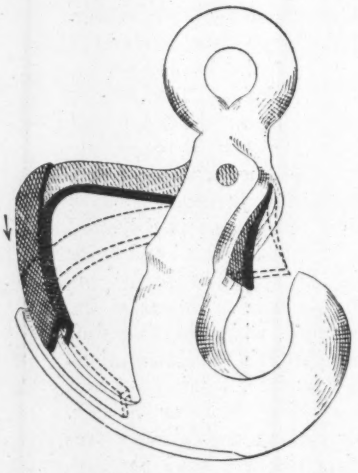
COST OF IDAHO HIGHWAY SURVEYS

Miles Surveyed	Character of Country	Season	Extent of Work Done	Av. Mi. per Day	Max. Mi. per Day	Av. Cost per Mi.	Total Cost
33.6	Open, hilly.....	Nov.	*P. & L.	1.0	3.0	$30.75	$ 1,033.40
30.5	Open, level.....	Dec.	P.	3.0	3.3	23.68	722.46
20.0	Valley, rough.....	Jan.-Feb.	P. & L.	0.7	3.6	35.05	701.17
20.0	Valley, rough.....	Mar.	P.	3.2	4.3	15.95	319.00
92.0	Open, level.....	Mar.-Apr.	P.	5.4	10.5	6.77	623.14
124.0	Open, rough.....	May-June	P.	3.0	7.2	9.09	1,127.19
89.0	Open, diversified..	June-July	P.	5.6	8.8	4.65	413.95
38.0	Open, very hilly..	July-Aug.	P. & L.	1.9	5.7	14.38	546.22
52.0	Valley, rough.....	Aug.	P. & L.	1.44	4.4	28.97	1,506.54
30.0	Mountainous.....	Sept.-Nov.	P. & L.	1.3	2.9	30.15	904.62
36.0	Open, rough.....	Mar.	P. & L.	1.7	4.4	17.48	629.33
112.0	Open, rough.....	April-July	P. & L.	1.3	4.4	26.00	2,912.20
70.0	Mountainous.....	Nov-Feb.	P. & L.	0.96	2.1	43.20	3,024.57
71.0	Mountainous.....	Aug.-Oct.	P. & L.	1.8	6.4	24.44	1,735.56
187.0	Open, rough.....	Dec.-May	P. & L.	2.3	7.9	11.90	2,222.37
57.0	Open, rough.....	June-Aug.	P. & L.	2.8	8.1	9.07	516.56
105.5	Open, level.....	Jan.-Apr.	P.	2.8	6.3	8.30	877.42
62.0	Open, diversified..	May-June	P.	2.5	8.0	7.77	482.15
93.0	Open, diversified..	July-Aug.	P.	1.6	6.8	14.14	1,315.11
61.0	Open, rough.....	Sept.-Oct.	P.	2.8	6.0	10.15	619.13
24.0	Open, diversified..	July	P.	6.0	8.8	6.19	148.59
39.0	Open, diversified..	Aug.	P.	3.9	5.5	4.76	185.80
1446.6							$22,292.58

Average cost per mile, $15.41.
* P. indicates Preliminary line. L. indicates Located line.

A Novel Method of Sea-Wall Construction is proposed by A. M. Pegram, of Newburgh, N. Y. Large blocks are to be made by pouring concrete into wooden packing boxes in place where the wall is required. According to the scheme, the boxes are to be lined with waterproofing paper, placed on the beach at low water and filled by chuting concrete from a mixer on a near-by bulkhead or shore. Once the box is filled, the cover is nailed on and a second tier of blocks built up in the same fashion, the construction to be continued to form a sea-wall. Commencing work in the fall when the beach is already made up, it is thought that the undertow of the winter as the work progresses will cut away the beach and allow the blocks to settle to hard bottom. Mr. Pegram estimates that on the Jersey shore, for which the scheme is originated, such a wall of sufficient strength to survive the ordinary Atlantic weather could be built at a cost of $16.50 per lin.ft.

Another Safety Hook—A safety hook approved by the Workmen's Compensation Service Bureau is shown herewith. Although intended for handling ladles in foundries, there is



SAFETY HOOK

no reason why it should not be used on other service. We recently called attention to two other safety hooks, in our issues of Feb. 18 and Apr. 1, pp. 353 and 656, respectively.

Editorials

A Refuse-Destructor Question

The low cost of hydro-electric power at Toronto, Ont., is given as the reason for awarding a contract (noted elsewhere in this issue) for a 180-ton high-temperature refuse destructor without provision for heat utilization in power production. In view of the fact that comparatively few of the 25 high-temperature destructors previously built on this side of the Atlantic are utilizing heat except for work purposes, it is pertinent to ask whether our American cities generally, at least those of the United States, would not do well to cut out heat-utilization plants from future refuse-destructor installations.

A Very Low Price for Brick Roads

We reported in the Construction News supplement last week the award of a contract for some five miles of brick-paved roads which are to be built by the New York Board of Water Supply on top of the dikes and embankments around the Ashokan reservoir in the Catskills. The contract price for the brick paving on this road is $1.60 per sq.yd. This does not include, however, the concrete foundation nor the cement used in grouting the brick, which is furnished to the contractor. The contract price for the foundation—concrete, 5 in. thick—is $3 per cu.yd., not including the cost of cement. The contract price for the cement is $1.20 per barrel. This brings the total cost of the brick paving to about $2.30 per sq.yd., including the foundation. How low this figure is may be realized when it is understood that the brick for the work will probably have to be brought from Ohio and that in the Ohio paving-brick districts $2 per sq.yd. is considered a fair price for brick paving. The very low prices on this contract are due to exceptional conditions which are seldom duplicated. Competition among contractors is very sharp at the present time, and the successful bidder has a large plant and working force on the ground, so that he could afford to name a price lower than any other contractor.

The specifications for the brick for this work called for "blocks with square edges, with wire-cut or otherwise satisfactorily roughened side surfaces for the adhesion of the filler." All bricks and other materials are to be at least equal to the specifications recommended by the National Paving Brick Manufacturers Association in 1914.

The engineers of the Board of Water Supply have adopted vitrified brick pavement for these roads in the belief that the small expense of maintenance of the roads will more than offset their greater cost, so that in the long run they will be the cheapest roads the city could build that would meet the requirements. It will be recalled that the Board of Water Supply engineers proposed to use brick paving for a much larger mileage of roads around the Ashokan reservoir, contracts for which were let some two years ago. The bids at that time received for brick paving, however, were in the neighborhood of $1 a sq.yd. higher than those which have just been named; and under these circumstances the financial department of the city overruled the engineers and ordered bituminous macadam to be used instead of brick paving.

The San Francisco Struggle

The long and varied history of struggles for municipal ownership of water-works contains no chapter longer or more interesting than the one dealing with San Francisco. There was reason to hope that the chapter would be completed on Apr. 20 when the people voted on buying the property of the Spring Valley Water Co. on an agreed valuation of $34,500,000. A majority of 6457 declared for the purchase, but a two-thirds majority was required and so the project was defeated.

The defeat bids fair to prolong to at least forty years the movement for municipal ownership begun 38 years ago, for now the valuation of the property, which was halted when a purchase price was agreed on by representatives of the city and company, is expected to proceed, and it seems unlikely that it will be completed and another purchase vote taken within less than two years. The energies of engineers will therefore continue to be devoted to valuation proceedings instead of to enlarging the works.

That San Francisco will eventually own its water-works is a safe prediction. For years it has been the only city in its class having privately owned water-works. The other large cities of the country, many of which were once served with water by private companies, established municipal plants by purchase or construction long ago—except that the change at New Orleans was of recent date. Scores of smaller cities have also made the change, and thousands of cities, large and small, owned their water-works from the start. The example of its sister cities, both in the United States and abroad, and the persistence with which San Francisco has kept up the struggle for nearly four decades unite to indicate that San Francisco will soon be in the municipal-ownership column. Already it has built a special fire-protection system of water-supply and made a start on the Hetch Hetchy project.

The Watertightness of High Concrete Standpipes

The reinforced-concrete standpipe at Attleboro, Mass., has long been the subject of adverse comment and the horrible example with which the advocates of steel tanks have pointed many a moral. As far back as 1909 the number of criticisms of the structure coming to this office was so great as to warrant a special trip to the site for the express purpose of examining and recording its condition. From time to time since then rumors of its imminent collapse have had more or less currency among the laity, and its splotched appearance has been the common talk of those engineers who realized that the relation of

surface to safety was not necessarily direct. Until quite recently most of the comments and criticisms have been by word of mouth, and such printed statements of the condition of the structure as existed have had little circulation. Within the past few months, however, the condition of the structure has come in for a good deal of public discussion in engineering circles in New England; so much, in fact, that we have thought it worth while to put on record in this issue a brief history of the structure and some description of its past and present conditions. This is particularly timely because the standpipe has just been inclosed in a brick facing, an expensive confession of its poor appearance, at least.

The experience with the Attleboro standpipe has duplicated, possibly in a more pronounced fashion, the experience with practically every reinforced-concrete standpipe in this country over 75 ft. in height. This means that for water pressures exceeding 30 lb. per sq.in., *under the methods of design and construction which have hitherto prevailed,* it is nearly impossible to procure a water-tight concrete in large monolithic structures; for heads lower than that a great number of handsome tanks and standpipes testify to the possibilities of a water-tight concrete and for heads much greater, small, carefully made pipe sections are in successful use.

It is, then, apparently necessary that the prevailing methods of building such high standpipes be radically changed if they are to continue in use. According to L. J. Mensch, a correspondent in this week's issue of ENGINEERING NEWS, certain definite precautions in design and construction may be taken to insure a water-tight standpipe for heads even as high as that for which the Attleboro tank was designed. His precautions comprise a rich mix, the observance of certain generally disregarded conditions of strain, the continuous laying of the concrete and the placing of an inner waterproofing mat—all of which precautions, according to our correspondent, have been long followed in European practice with entirely successful results. Some of them, of course, are common to American practice.

These appear to be reasonable instructions, but, unfortunately perhaps, the American engineer is loath to accept rather vague testimony as to European practice as precedent for his own structures. What he wants are the results under what he considers comparable conditions. If, then, a tabulation could be made of the methods and materials used on existing American standpipes and these data tied up to the variable present conditions of the structures, some definite information, quite possibly agreeing with the European model, might be made available.

Meanwhile, it will be well to recognize that most of the high standpipes which have been giving leakage trouble were built some years ago, when the standards of concreting were not quite so high as they are today. This does not mean that the strength of that concrete is materially lower than that of the best modern concrete, but it does mean that ten years ago engineers and contractors did not consider it worth while to bestow that scrupulous study on materials, mixing and placing that it is now realized can alone produce a dense concrete, water-tight under high heads.

Another obvious lesson which can be learned from the Attleboro tank is pointed out by Mr. Mensch. Why subject tanks or standpipes to the probability of porous percolation under a very high head, when a perfectly tight concrete can be guaranteed under a much lower head, the desired capacity being gained by a larger diameter? The topographical conditions at standpipe sites rarely preclude the enlarging of the horizontal section with a corresponding reduction of the height.

It is worth considering, too, whether it would not be feasible to build into the concrete wall of the tank for the lower 20 or 30 ft., say, a continuous cylinder of sheet steel against which an interior face could be plastered by the cement-gun or some other method, and which could be used in construction as the interior form for the concrete wall. Such a cylinder would need little structural strength and would act as an effectual dam against the water at the place where the water pressure was highest. If the details of placing it could be worked out, it could not possibly cost as much as a heavy waterproofing mat such as was finally applied at the Attleboro and the Westerly standpipes.

These criticisms should not be construed to apply to the small reinforced-concrete standpipe or tank. In many places good appearance is so important as to demand a concrete structure instead of the ordinary unattractive steel tank, and experience has shown that with due care such a concrete tank can be built so as to give complete satisfaction both from a structural and artistic viewpoint. The problem, then, is merely one of magnitude. Assuming certain careful methods of design and construction, it is quite possible to make a water-tight concrete wall under head of, say, 50 ft. Will not those same methods produce equally satisfactory results for heads of 100 ft.?

Engineers' Recommendations for Amendments to the New York Constitution

In our issue of Mar. 25 last we reported a meeting of engineers held to discuss amendments to the New York constitution. Elsewhere in this issue we publish in full the recommendations adopted by a committee organized after that meeting and made up of members of five of the national engineering societies and two of the engineering societies located in New York City. These recommendations have been printed and sent to each member of the Constitutional Convention with a letter explaining why the engineers have deemed it proper to put their views before the convention. The general tenor of this letter may be judged from the following paragraph:

> **We are in accord with a conservative tendency in the convention, and believe that the constitution should be as brief as may be and should deal mostly with principles of government, rather than with details of organization, but we are persuaded that the technical developments of the period which has intervened since the present constitution was adopted have introduced into government large problems in connection with public works and utilities requiring legislation which should be based on constitutional provisions.**

To some it may seem outside the province of the national engineering societies to interest themselves in amendments to the New York constitution, since a truly national society should be no more concerned with the provisions of the New York constitution than with the constitution of Maine or California. But important changes in the organic law of New York are very likely

to be copied by other states of the Union. If, therefore, engineers can succeed in introducing reforms which will put engineering work in the State of New York on a better basis, it will be a valuable aid toward similar reforms in other states.

Of the eight recommendations which the committee has submitted, six have to do with the organization of the state's public service, and particularly with that part of the public service in which engineers are engaged. The committee's first recommendation is that the office of state engineer and surveyor should be abolished and that all public work of every sort carried on by the state should be placed in charge of a Department of Engineering and Public Works. If nothing else of the committee's recommendations impresses the Constitutional Convention, surely it must be impressed by the fact that a committee of engineers unanimously recommends that the office of state engineer shall be abolished.

Experience in New York State has abundantly proven that when candidates for state engineer have to run the gauntlet of nomination and election by popular vote, it is purely a matter of luck if an engineer of competence and integrity receives the office. A party nominating convention generally exhausts its energy in the fight over the candidates for governor and lieutenant-governor. After that matter is settled the delegates are chiefly anxious to get the rest of the ticket out of the way as quickly as possible and go home. Some obscure man of whom not one in a hundred of the delegates ever heard, may be placed in nomination for a minor office, and his choice is made by acclamation. Nor is there likelihood of greater care in the selection when a candidate is chosen by the direct primary. What does the average voter know concerning the relative professional qualifications of the engineers competent to fill the office of state engineer?

Turning now to the recommendation that the Department of Engineering and Public Works should be headed by three commissioners, it will be noted that the committee here rejects the theory that the way to get results is to give one man unlimited power. While it is often advisable to give one man great powers in the execution of some specific work, it is not wise to give one man unlimited power where the work is supervision rather than execution.

The proposed Department of Engineering and Public Works would have the entire responsibility for New York's canal system, representing an investment of over $200,000,000; of the state highway system, costing over $100,000,000; of all the buildings owned by the state, from the capitol at Albany to the structures used by the state for charitable and penal purposes, hospitals, asylums, prisons, etc.; of the work which the state is likely to undertake for the development of water-power on the state's lands; of the state's forests, and of work undertaken in connection with its resources of fish and game.

It will be obvious that the administration of all these varied works should not be entrusted to one man. It will be obvious also that the duties of the three commissioners placed in control of this department will not be to deal with the details of any particular part of these vast works, but to select competent heads for each section of the department's work and to see to it that these heads administer their work on proper lines.

It will probably take away the breath of the politicians when they read the recommendation that these commissioners should have a 12-yr. term of office; and it is perhaps too much to hope that such a recommendation will be carried out. But the underlying idea is the performance of the public work in an economical and efficient manner and not the creation of places for political workers. It would seem, therefore, that the 12-yr. term of office might appeal to the public, especially at this time when New York is sorely pressed by the burden of heavy taxation as a result of the enormous growth in state and municipal expenses.

If anyone thinks that the 12-yr. term of office is too long, we would suggest that he consider whether he would care to invest his money in a business corporation, the managers of which held their positions only for short terms and with the understanding that they would probably be discharged at the end of that term no matter how excellent the work they had done. One of the great handicaps which prevent the government business from being carried on efficiently and economically is that those in charge are elected or appointed for limited terms and are in many cases lost to the public service just when they have become thoroughly familiar with and efficient in the performance of their duties.

The principle of continuity of policy is observed by having only one commissioner go out of office at a time. Two commissioners can carry on the work while the newly appointed commissioner is gaining his experience.

The Department of Public Utilities, of course, is designed to supersede the present Public Service Commissions for the First and Second Districts. It will be noted, however, that the powers granted to this department are much broader than those possessed by the present commissions. It would have the power to supervise and regulate not merely the franchise corporations operating public utilities, but all work carried out by the municipalities themselves.

This is in accord with the experience gained in Pennsylvania, Massachusetts, Wisconsin, and elsewhere. It is very greatly to the public advantage that some state board shall have power to supervise the plans adopted by cities for their public works. The department would supervise county work as well; and the advisability of this is obvious to anyone who realizes how much inefficiency and political corruption are prevalent in the carrying on of county business in most parts of the United States.

It is worth while to emphasize the clause that each commissioner of the Department of Public Utilities "should have had experience in connection with public utilities which would fit him for the duties of the office, and at least two of the commissioners should be professional engineers in good standing." It is generally agreed that the great question whether state control of public utilities can be made a success depends more than anything else on the character and ability of the men chosen for appointment on our public service commissions.

Of course, we must recognize that the quality of the men selected as public utility commissioners will finally depend upon the good judgment and patriotism of the governor making the appointment. A stream cannot rise higher than its source, and if the voters bestow the office of governor on some third-rate man, he will be apt to select third-rate to fifth-rate men for his appointees, no matter what the letter of the constitution may require. There can surely be no harm, however, in embodying in

the constitution an ideal of the qualifications these officers should possess.

Space permits only brief reference to the seventh and eighth recommendations of the committee. The first of these relates to the question which has so often agitated engineers—reform in the practice regarding expert testimony in the courts. The second would remove the foolish prohibition now in the constitution against the cutting of trees in the state's forest reserve, which has for a score of years prevented the state from making business-like use of its great forest tracts. The last clause also aims to make possible work by private enterprise for the development of water-power, land drainage, etc., through the use of the power of eminent domain, a matter discussed in our issue of Apr. 8, 1915, p. 689.

In regard to this latter subject it may be noted that in the incorporation of this feature in the constitution some method will have to be worked out of safeguarding its use. In other words, some public authority must be empowered to say what private enterprises may be given the right to condemn private property; otherwise, a dangerous scramble might take place and very serious infringement of private property rights might occur.

The engineering profession as a whole is to be congratulated that these recommendations to the New York Constitutional Convention are made not by individual engineers nor any single engineering society, but by a committee made up of members of seven of the leading engineering societies of the country. The committee, moreover, has only begun its work. It is quite within the possibilities that the committee may make further recommendations to the convention concerning other matters of direct interest to engineers; and it has offered its services to the convention for advice on any technical matters of importance upon which the convention may desire information.

Letters to the Editor

Thermophone or Telethermometer

Sir—In ENGINEERING NEWS, Dec. 10, 1914, p. 1172, is an article describing the use of so-called "thermophones" for indicating temperatures in the interior of the Kensico dam. I should like to know who invented this name and why. From the description, the instrument indicates by means of a Wheatstone bridge and galvanometer, depending upon the variations in resistance of the wires according to temperature; the phenomenon of sound has nothing to do with it. Did the inventor think that because a "telephone" enabled sound to be detected at a distance, therefore a "thermophone" should mean an instrument for detecting temperatures at a distance? This is like the etymology of a slang word once current—"locofoco"; meaning, I believe, a self-lighting device, ignorantly named so because the inventor apparently thought "locomotive" meant self-moving, therefore "locofoco" should mean producing fire of itself.

In these days of tremendous development of the natural sciences we cannot afford to spend much time on studying the dead languages (in spite of the debt owed to them by our own), but it appears to me that there ought to be enough knowledge abroad to prevent useful inventions from being made ridiculous by barbarous misnomers. I may be answered by the disclosure of a telephone attachment, heretofore unmentioned; but I am waiting to be shown.

H. J. KENNEDY.

Tacoma, Wash., Mar. 20, 1915.

[Undoubtedly, "telethermometer" would be a better word for the instrument in question. The use of "thermophone" probably arose from a former use of a telephone receiver as an indicator of electric balance of a Wheatstone bridge. However, the author and the editor erred with common practice, as many similar articles in engineering literature will testify.—EDITOR.]

Proper Design and Construction of Concrete Standpipes

Sir—In connection with your current discussion of concrete tanks and standpipes, I would like to submit what I consider to be some of the essential requirements of good concrete-tank design and construction.

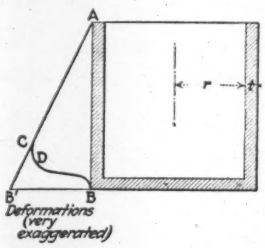
It must be kept in mind that ordinary 1:2:4 concrete, even if well tamped and spaded, is not waterproof for pressures of more than a few feet of water. Laboratory tests may prove such concrete waterproof for higher pressures; in practice an absolutely uniform mixture is nearly impossible to obtain and there will be spots where the mixture is 1:3:6 or worse. The writer would advise a concrete mixture of one part cement to 1.3 part aggregate for a head of water of 80 to 100 ft.; for heads of 50 to 70 ft., a 1:1.5 mix; for heads of 30 to 40 ft., a 1:2 mix; and for smaller heads, a 1:2.25 mix. These mixtures are based on French practice, where concrete tanks have been in use for 50 yr. and where the walls are made much thinner than in this country. Even thick walls will not show up well, if the aggregate is increased by more than 50 per cent. over the above-mentioned figures.

Such rich mixtures cost only $1 to $2 per yard more than a 1:2:4 mixture, amounting only to 5c. per sq.ft. of tank wall in medium-sized tanks and to 15c. in the largest tanks, or to about $400 in the Westerly tank and about $1500 in the Attleboro tank.

Even rich mixtures and careful workmanship do not prevent leaks in construction joints; it is therefore best to build important tanks in a continuous operation, as is commonly done in grain-elevator construction. Even with this method of construction, no one but an amateur would expect a tank to be absolutely water-tight. This can be assured only by a carefully and skillfully applied waterproofing coat. In tanks of moderate height, this coat should consist of a so-called slush coat of neat cement

applied with a brush, followed by two coats of about ⅛-in. cement mortar of a 1:1 mix, tempered with hydrated lime. For higher tanks, a coat of the best refined asphalt of such consistency that it can be applied cold with a trowel about $\frac{1}{16}$ in. thick and covered with a heavy coat of cement mortar for protection will give a waterproof structure.

Most of the high concrete standpipes in this country are not water-tight because their structural design is greatly at fault. These tanks, although of unusual sizes, were designed as thin pipes of uniform pressures throughout without end-restraint. While this may be done properly in steel tanks, it leads to bad design in concrete tanks on account of the great thickness of the walls. The walls are comparatively heavy and, though without connection to the bottom, can sustain a considerable cantilever action.



The elastic deformation of a concrete tank with a uniform thickness t of the walls, if unrestrained at the bottom, is denoted in accompanying figure by the line AB'. The increase of radius in the Attleboro tank, for example, would amount to 1 in. at the bottom. The restraint will cause the tank to deform according to the line $ACDB$, producing a maximum negative moment at B with tensile stresses at the inside of the wall, and a maximum positive moment at D with tensile stresses at the outside of the wall. With r and t in feet, the height of the point D above the bottom varies from 0.4 rt for values of rt of about 10 to 0.12 rt for values of rt of about 100. The exact theory may be found in Grashof's *Elasticität und Festigkeit,* Berlin, 1878, and simplifications of the theory have appeared in *Beton und Eisen* in many issues since 1907.

For the Attleboro tank, for example, $M_B = 63{,}000$ ft.-lb. per lin.ft. and $M_D = 13{,}200$ ft.-lb. per lin.ft., requiring 1.9 and 0.6 sq.in. per lin.ft. of high-carbon steel reinforcement respectively. As this reinforcement is absent, we need not be surprised that the concrete is spalling and the tank unsatisfactory. On account of the cantilever action, a portion of the water pressure is transmitted through the bottom, causing there circumferential and radial stresses.

To counteract the cantilever action, some engineers have advocated separating the tank walls from the bottom, but theory shows that the walls cannot move even if set on frictionless bearings before the cantilever action is exhausted, because the interior work to deform the lower portion of the tank as a cylinder is a great multiple of the work necessary to deform it as a cantilever. In addition, there exists a considerable friction at the base even if graphite and copper bearings are introduced, because it is practically impossible to produce a plane joint, and the contact surfaces are undulating in both directions, greatly diminishing the movement. The cost of the joint is, as a rule, greater than the cost of providing the proper amount of vertical reinforcing as above outlined.

Another great mistake generally made in tank design is the use of great heights in comparison to the diameter of the tanks, not only involving a greater amount of concrete and steel and formwork, but also making the task of waterproofing more difficult. A tank 40 ft. in diameter and 60 ft. high is considerably more expensive than a tank 50 ft. in diameter and 38 ft. high, the cost of roof and elevated bottom also being considered.

L. J. MENSCH.

138 N. La Salle St., Chicago, Ill., Mar. 31, 1915.

Progressive Axle Fractures

Sir—Referring to your editorial of Mar. 11 on the breakage of the truck axle causing a wreck at Woodlyn on the Baltimore & Ohio R.R. I have seen and examined a large number of such cases of progressive or, as they are sometimes called, detail fractures, not only in axles from locomotives and railway cars, but also in such automobile parts as drive and differential shafts, steering knuckles and crankshafts. Many cases have also been observed in miscellaneous parts of machines. In each case there has been either a reversal of strain in the piece or else repeated application and release of the load. In most cases the breakage occurred at a corner, so to speak, where there was an abrupt change in section, the location being generally accompanied by either a sharp corner or a very small fillet. It is not recalled that such a fracture ever developed in the presence of a large fillet except in a few cases, two of which were as follows:

A number of old-type locomotives continually broke their main crankpins, either just inside or just outside of the flange between the side-rod bearing and the wheel hub. An increase in the size of this pin, using the same quality of material, had stopped the trouble entirely; but for my own information I figured out the stress in the old-style pins, using H. L. Pomeroy's formulas, which appeared in a series of articles in the *Railroad Gazette* about that time. The results showed a fiber stress of about 19,000 lb. per sq.in.; and as the elastic limit of the steel used was probably not over 40,000 lb., the cause of the difficulty was evident.

The second case was the experience of a railroad in connection with car axles. Many years ago the metal used was changed from wrought iron to steel; and as it was felt that a material nearly like wrought iron in its physical characteristics would be suitable and proper, low-carbon steel, I think of about 0.20 carbon, was used. These axles were applied in the regular course of repairs, and, much to the surprise of everyone, they began to develop detail fractures. The result was that it became necessary to increase the elastic limit by increasing the carbon content. After this was done there was no more trouble.

The two cases illustrate the common methods of avoiding detail fractures—that is, decreasing the fiber stress by increasing the size and increasing the elastic limit by a change in material. The result in both cases is the bringing about of a proper ratio between the fiber stress and the elastic limit.

Now in my experience, with the exception of the above two cases and one or two others of the same character, the percentage of failures by detail fracture is very small, and the trouble may be frequently assigned to improper construction or adjustment of parts, such as permitting the bearings of an automobile crankshaft to become loose or badly worn, thus increasing the fiber stress beyond the point for which it was designed.

It is undoubtedly true that the breakage of the axle

referred to in your editorial was one of but very few instances of difficulty with the particular design, and it would not be surprising if it were an entirely isolated case. It certainly is not an ordinary case of detail fracture, nor can it be ascribed to the usual causes of such breaks.

The essential points are, in my opinion, that the breakage is in the largest part of the axle and that this break occurs at the peculiar score referred to.

It would appear that the only difference between this axle and probably hundreds of others of the same design, which have been giving no trouble, is the score. It would therefore appear proper to conclude that the score was the cause of the breakage.

It does not seem credible that, if any such fiber stress as stated in your editorial is produced by impact, as you suggest, any axle at all could stand up, as all axles are subjected to the same strain. In the case of the main crankpins cited above, the ratio of elastic limit to fiber stress was not greater than 2.2 to 1; or, as it might be stated, the factor of safety based on the elastic limit was 2.2.

If the writer's recollection is not in error, in the articles above referred to Mr. Pomeroy showed that, for alternating stresses, the factor of safety based on the elastic limit should be between 4 and 5, and that if it is less than 4, detail fractures will result. It is also the recollection of the writer that these figures are based on static stresses.

It is not, therefore, believed necessary to assume that a fiber stress of 35,000 lb. was generated in the axle referred to to account for the fracture.

It is a matter of common knowledge that nicking a bar of steel will make it break under bending strain much more easily than will a similar bar of a size equal to that at the bottom of the nick, and that the nick may be made by a hacksaw or in a shaper; so that the question of shock does not enter, as would be the case if a chisel were used to make the nick.

It is believed also that tensile tests of such nicked specimens show the same tensile strength per square inch as in the original section. But I do not recall any bending tests made on nicked specimens, nor any tests of such pieces under alternating stress, comparing the results with the strength of normal pieces.

In a general way it would seem that sharp corners, nicks and similar peculiarities concentrate the strain in some way, either increasing the fiber stress or decreasing the resisting power of the section at that point, though why this occurs or the exact method of its occurrence, I do not know.

In this particular case, therefore, it would appear entirely plausible that the score was the cause of the trouble.

It might be possible that one of the following conditions could have contributed to the breakage—and indeed they may be the controlling causes in other cases of detail fracture, while sharp corners, nicks, etc., may be incidental and not basic in their influence:

(1) Segregation of some of the elements at the broken section. This might be shown by a microscopical examination.

(2) Improper heat treatment at some time during the manufacture or use of the axle.

The microscope should disclose any such condition.

I believe that it should not be overlooked that physical tests cannot give the conditions at the line of fracture, and that in cases of segregation or improper heat treatment the microscope will give more and better information than can be obtained by any other method.

I would also call your attention to the reference on pp. 26 and 29 of vol. 6 of the *Journal of the Institute of Metals*. I am not personally familiar with the researches of Ewing and Humphrey and of Stanton, but it would appear possible that the score around the axle distorted the metal sufficiently to cause minute cracks on the exterior of the surface and for a minute distance below it. If the start is made, it is not difficult to see what the result will be.

It may be that the researches above referred to would throw the light on the subject necessary to give a complete explanation. I believe very strongly that the use of a microscope in a case of this kind is of far more service than any chemical or physical test, because by its use the physical characteristics of the metal can be actually observed without injury to the apparently defective parts.

S. W. MILLER.

No. Pearl and Tivoli St., Albany, N. Y., Mar. 27, 1915.

[It is true that Mr. Howard's report on the Woodlyn accident emphasized the circumferential score on the surface of the axle as the probable starting point of the detail fracture and its probable cause. The scoring, however, as shown in the views accompanying the report, appears to have been hardly more than a faint scratch on the surface of the axle. If so slight a surface imperfection can cause the fracture of a piece of steel 7½ in. in diameter when subjected to transverse stress, the fact ought to be more widely known to engineers. For that matter the fact that our correspondent points out that a nick or an abrupt change in cross-section greatly reduces the transverse strength of a piece of metal ought to be more generally appreciated by engineers.—EDITOR.]

NOTES AND QUERIES

The lift bridge at Fairport, N. Y., described by Charles R. Waters in our issue of Apr. 15, page 704, was fabricated and erected by the Lackawanna Bridge Co. as subcontractor under H. S. Kerbaugh, the general contractor for this section of the Barge Canal. The Lackawanna Bridge Co. built 12 bridges and two steel guard gates on this contract.

Construction of a 6-Ft. Segmental-Block Sewer

BY BENJAMIN WILK*

The construction of a 6-ft. segmental vitrified-block sewer 9114 ft. long, at Virginia, Minn., a city of 15,000 population on the Iron Range, marks the introduction of a new style of sewer in that section of the state. The sewer is the largest of its kind, in the knowledge of the writer, so far constructed in Minnesota. It acts as the main outlet sewer for the storm water of the city and also as the carrier of the overflow from the sanitary sewers. Engineers are watching it with much interest, as the material used is cheaper than the pipe now being generally employed and can be laid with much greater speed.

The sewer was laid on an 0.08% grade, and the digging ranged from 12 to 27 ft. in depth. The line lay along a wagon road for about a mile and then beside a railroad track, which made it necessary to lay out several curves in order not to trespass on private property and still keep

*Assistant City Engineer, Virginia, Minn.

away from the roads. Three simple curves up to 8° and as long as 400 ft. and one 6° reversed curve 450 ft. long were easily rounded by the use of the segment blocks.

Excavation was done by a steam shovel which traveled directly over the sewer on 12x12-in. by 32-ft. timbers. The boom was long enough to dig 17 ft., and the dirt was thrown to either side, whichever was most convenient. The shovel was self-propelling and was on a swivel, which allowed it to take the timbers from behind and place them ahead of itself. When the extra digging was only a couple of feet more than the shovel could dig, laborers handled it by shovel to the surface in the usual method, but when the digging went down farther, skips were used, built up of a number of 3-in. timbers sided up on three sides, but the whole skip was small enough to be easily handled in the trench. The skips were hoisted out by a clamshell after the orange-peel had been taken off and cables attached to the skips. In this way several skips could be worked in the trench at one time.

staggered as in the laying of brick. With this arrangement the springing line came in the middle of the block at the quarter point, making a much stronger section than if there were a joint at the springing line. The blocks being grooved both longitudinally and horizontally, very little cementing was needed to make the joints secure.

Each segment block was 2 ft. long and 7½ in. thick and weighed 93 lb. Twenty segments made up the complete circle. The blocks were unloaded from the cars and placed alongside of the trench. They were then slid down on planks into convenient position for the layers.

When the lower half of the sewer was finished a number of feet ahead, a semicircular form of wood (Figs. 2 and 3) about 16 ft. long on a 6-ft. diameter and supported by a triangular arrangement resting on the blocks already in place was used for the upper half of the sewer. On this form the men would place the blocks as fast as they were lowered. A coating of cement mortar would then be smeared over the joints. Such a coating was

LAYING A 6-FT. SEGMENTAL VITRIFIED-BLOCK SEWER AT VIRGINIA, MINN.

(1, Reading for backfilling. 2, Laying the invert blocks. 3, Scooping out the trench bottom for the invert blocks. The trench bracing and the arch centering may be seen in 2 and 3)

Digging was mostly through hard clay, though considerable rock was struck for a distance of 1400 ft. through the deepest digging. The sides of the trench were supported at intervals of 5 ft. by bracing made up of two 3x12-in. timbers and two jacks. The only time when there was much caving was during a very wet season of three weeks. The excavation was carried on night and day, and as much as 130 lin.ft. was dug in 24 hours.

The bottom of the trench was rounded out by hand labor (Fig. 3) to receive the segment blocks directly, though at first a 1-in. layer of a 1 to 5 sand-cement mixture was used as a cushion. The latter method was discarded when the digging was found to be good. To secure a well-rounded bottom, grades were set every 25 ft. on boards nailed to the jacks and the depth of digging noted thereon. On curves the grades were set every 10 ft. Directly underneath the grade stake a semicircular form made up of boards so that its width was the same as the thickness of the pipe was so placed that its upper side was at sewer grade, so that a string stretched from the center of the form to the invert of the pipe already in would be the grade of the invert.

The first row of blocks was laid directly underneath the string, half of the block to one side and half to the other (Fig. 2), so that there was no joint at the invert. The other rows were then built alongside of this bottom row, also used on the inside of the pipe. The last block of the circle had to be shoved into place longitudinally.

When the severe cold weather came, in November, salamanders were used to keep the cement and sand warm and the sides of the trench from freezing. With the temperature down to —25° F., as it was during the latter part of December, a canvas covering was used.

The backfilling (Fig. 1) was started as soon as the cement had a good chance to set. From the surface men would shovel the dirt into the open space at the springing line. The long drop from the surface was almost sufficient for the dirt to be compacted, but the best method is to have the dirt rammed in at the springing line. After this preliminary filling in had been done, a clamshell, as well as a dragline working from a gasoline engine known as a "sky-bow," was used for the rest of the backfilling. Care was necessary to see that no rocks were allowed to drop any distance on the pipe.

When the backfilling was completed men were sent through the sewer "pointing up" any joints that might have opened up by action of the dropping of the dirt on the pipe. A rich cement-mortar mixture was used.

The contractors were Lawrence-McCann Co., of Virginia, Minn. The plans and specifications were prepared and the work was done under the direction of E. F. Johnson, City Engineer.

Methods of Approximate Integration

By Willis Whited*

SYNOPSIS—In engineering work the value of a definite integral must often be determined, when the integration cannot be performed. Various formulas which have been proposed for this work are given, and by applying them to eleven functions which could be integrated, the correct result is compared with the results given by the several formulas. The polygon method is shown to be crude, Simpson's rule much more precise, but another Cotes formula still more precise while just as easy to apply.

Engineers and other students of applied mathematics occasionally have to obtain the values of definite integrals which cannot be determined by the ordinary methods of integration. Various approximate methods have been devised for accomplishing this purpose, a few of which are herewith presented. The demonstrations are, in some cases, long and tedious and require a considerable knowledge of higher mathematics. We will, therefore, confine ourselves to a brief discussion of the methods, the kinds of problems to which they appear to be most applicable, and the degree of accuracy secured, and refer to various treatises for demonstrations. The references will be to books which are not out of print, but, unfortunately, some are in foreign languages.

Approximate methods of integration are used, not only for evaluating stated definite integrals, but also for integrating unknown functions, of which a series of values is known by measurement or experiment.

The writer has chosen a number of functions which could be exactly integrated, applied the various approximate methods to them, and compared the results with the correct values of the integrals between stated limits of the variable. The results of the comparison are tabulated farther below. The values in the table represent the areas of figures bounded by the graphs of the functions and the terminal ordinates.

1. *Polygon Method*—What may be called the polygon method consists of substituting for the true curve a polygon passing through the ends of equidistant ordinates. This method is well known. Its accuracy depends on how close the ordinates are spaced. By this method, the formula for the area is:

$$A = \int_a^b f(x)\,dx = h\left(\frac{y_1}{2} + y_2 + y_3 \ldots y_n + \frac{y_{n+1}}{2}\right) \quad (1)$$

in which, as in all the formulas to be given, y_1 and y_{n+1} are the extreme ordinates, y_2, y_3 . . . y_n are the intermediate ordinates, n is the number of intervals (in this case all equal) between the ordinates, a and b are the extreme abscissas, and h is the distance between consecutive ordinates. This method is the simplest of all and can be made fairly accurate by making h small.

2. *Cotes' Method*—Cotes' method, published in 1722, is based on the fact that a parabola can be passed through the ends of any number of successive ordinates, the degree of the parabola being one less than the number of ordinates, i.e., a common parabola can be passed through three points, a cubic parabola through four points, a quartic parabola through five points, etc.

Let the space ab be divided into n equal parts. If n is even, a series of common parabolas can be passed through the ends of the ordinates. If n is divisible by 3, a series of cubic parabolas can be used, and if n is divisible by 4, 5, 6, 7, etc., a series of quartic, quintic, sextic, septic, etc., parabolas can be used, or a combination of parabolas can be used.

ERRORS OF APPROXIMATE INTEGRATION FORMULAS FOR ELEVEN FUNCTIONS

Formula	Fcn. (a)	Fcn. (b)	Fcn. (c)	Fcn. (d)	Fcn. (e)	Fcn. (f)	Fcn. (g)	Fcn. (h)	Fcn. (k)	Fcn. (l)	Fcn. (m)
(1)	+.091140183	−.0324115	−.0062747	+.0001531	+.000433651	+2.848224	+.0000275	+.0344235	+.011382	−.0003172	+.0721333
(2)	−.000000153	−.0025061	+.0011763	−.0073747	+.000001482	−.004490	+.0000084	+.0049937	−.000031	+.0000004	−.0023687
(3)	−.000000610	−.0042966	−.0046845	−.0150046	+.000003279	−.008531	+.0000095	+.0082939	−.000054	+.0000006	−.0038232
(4)	+.000000207	−.0013503	+.0015591	−.0034608	+.000000073	−.001494	+.0000079	+.0029419	−.000012	+.0000002	−.0017265
(5)	+.000000213	−.0010737	+.0058659	−.0012708	+.000000043	−.001257	+.0000076	+.0023535	−.000012	+.0000002	−.0012052
(7)	.....	+.0001383	.....	.....	.....	.....	.....	−.0002679	.....	.....	+.0000619
(8)	.....	.....	.....	.....	+.000000073	(3 terms)	.....	.....	.....	.....	.....
(9)	−.000110051	−.0057847	+.0026259	+.0174431	−.000026214	−.316798	+.0000089	+.0118288	-.001431	+.0000343	−.0090572

If $n = 2$ and the curve is a common parabola, the area is

$$A = \tfrac{1}{3}\,(y_1 + 4y_2 + y_3)\,h$$

If $n = 3$ and the curve is a cubic parabola,

$$A = \tfrac{3}{8}\,(y_1 + 3y_2 + 3y_3 + y_4)\,h$$

If $n = 4$ and the curve is a quartic parabola,

$$A = {}^{2}/_{45}\,(7y_1 + 32y_2 + 12y_3 + 32y_4 + 7y_5)\,h$$

If $n = 5$ and the curve is a quintic parabola,

$$A = \tfrac{1}{288}\,(19\,y_1 + 75\,y_2 + 50\,y_3 + 50\,y_4 + 75\,y_5 + 19\,y_6)\,h$$

If $n = 6$ and the curve is a sextic parabola,

$$A = \tfrac{3}{10}\,(y_1 + 5y_2 + y_3 + 6y_4 + y_5 + 5y_6 + y_7)\,h$$

Obviously, if n is any even number and a succession of common parabolas is used for successive pairs of spaces, the formula becomes,

$$A = \tfrac{1}{3}\left[\begin{matrix} y_1 + 4\,y_2 + y_3 \\ y_3 + 4\,y_4 + y_5 \\ y_5 + 4\,y_6 + y_7 \\ y_7 + 4\,y_8 + y_9 \end{matrix}\right] h$$

or,

$$\int_a^b f(x)\,dx = \tfrac{1}{3}(y_1 + 4y_2 + 2y_3 + 4y_4 + \ldots 4y_n + y_{n+1})\,h \quad (2)$$

This is known as *Simpson's Rule* and was published by him in 1743. As can be seen, it is only a particular case of Cotes' method.

If n is a multiple of 3, and a succession of cubic parabolas is used in similar manner, the following formula is obtained:

$$\int_a^b f(x)\,dx = \tfrac{3}{8}\,(y_1 + 3\,y_2 + 3\,y_3 + 2\,y_4 + 3\,y_5 + \ldots 3\,y_n + y_{n+1})\,h \quad (3)$$

*Engineer of Bridges, State Highway Department, Harrisburg, Penn.

If n is a multiple of 4, and quartic parabolas are used,

$$\int_a^b f(x)\,dx = \tfrac{2}{45}(7y_1 + 32y_2 + 12y_3 + 32y_4 + 14y_5 + 32y_6 + \ldots 32y_n + 7y_{n+1})h \quad (4)$$

If n is a multiple of 6,

$$\int_a^b f(x)\,dx = \tfrac{3}{10}(y_1 + 5y_2 + y_3 + 6y_4 + y_5 + 5y_6 + 2y_7 + 5y_8 + \ldots 5y_n + y_{n+1})h \quad (5)$$

The formula derived from the quintic parabola is more complicated and was not used.

The comparative accuracy of these various formulas is shown below.

Cotes' method is explained and the general formulas derived in Jordan, *Cours d'Analyse,* Vol. 2, 3d ed., pp. 125 to 129.

3. *Lagrange's Formula*—The formula given in Jordan at the foot of p. 126,

$$\phi(x) = y_1\frac{(x-a_2)\ldots(x-a_n)}{(a_1-a_2)\ldots(a_1-a_n)} + \ldots y_n\frac{(x-a_1)\ldots(x-a_{n-1})}{(a_n-a_1)\ldots(a_n-a_{n-1})} \quad (6)$$

is known as Lagrange's interpolation formula and is discussed in Chrystal's *Textbook of Algebra,* 5th ed., Part I, p. 450. To adapt the notation of the present article to that formula, substitute $f(x)$ for $\phi(x)$, a for a_1, $(a+h)$ for a_2, $(a+2h)$ for a_3, etc.

4. *Gauss' Method*—Another method, which is more accurate than any of those given above, but generally considerably more laborious, is known as Gauss' method and is discussed quite fully in Kiepert's *Integral-Rechnung,* 9th ed., p. 371. The formula follows:

$$\int_a^b f(x)\,dx = hc_1[(y_{1.1}+y_{1.2}) + (y_{2.1}+y_{2.2}) + \ldots (y_{n.1}+y_{n.2})] + hc_2[(y_{1.3}+y_{1.4}) + (y_{2.3}+y_{2.4}) + \ldots (y_{n.3}+y_{n.4})] \quad (7)$$

in which

$$y_{n.1} = f[a + h(4n - 2 - \alpha)]$$
$$y_{n.2} = f[a + h(4n - 2 + \alpha)]$$
$$y_{n.3} = f[a + h(4n - 2 - \beta)]$$
$$y_{n.4} = f[a + h(4n - 2 + \beta)]$$
$$\alpha^2 = \tfrac{4}{7}(3 - 0.4\sqrt{30}),\ or\ \alpha = 0.679962087$$
$$\beta^2 = \tfrac{4}{7}(3 + 0.4\sqrt{30}),\ or\ \beta = 1.722272623$$
$$c_1 = 1 + \tfrac{1}{18}\sqrt{30} = 1.304290310$$
$$c_2 = 1 - \tfrac{1}{18}\sqrt{30} = 0.695709690$$
$$4nh = b - a$$

If the operator is quite expert in handling radicals, this method can often be made quite simple. A more accurate formula can be obtained by Gauss' method, but it involves the solution of a bicubic equation and was therefore not tried.

5. *Euler's Method* is given by Jordan in his *Cours d'Analyse,* Vol. 2, 3d ed., p. 119. Its application is, in many cases, quite simple, if the successive differential coefficients of the function are not too complicated. Sometimes it converges quite rapidly and sometimes not. It has the advantage that the operator can judge fairly closely as to his maximum error.

$$\int_a^b f(x)\,dx = h[\tfrac{1}{2}f(a) + f(a+h) + \ldots f(b-h) + \tfrac{1}{2}f(b)] - \tfrac{1}{2}B_1h^2[f'(b) - f'(a)] + \ldots \frac{(-1)^{P-1}B_{P-1}h^{2P-1}}{(2P-2)!}[f^{2P-3}(b) - f^{2P-3}(a)]\ldots \quad (8)$$

in which f' f'' . . . denote firs , second, etc., differential coefficients of $f(x)$, and B_1, B_2 . . . are known as Bernoulli's numbers: $B_1 = \frac{1}{6}$, $B_2 = {}^1/_{30}$, $B_3 = {}^1/_{42}$, $B_4 = {}^1/_{30}$, $B_5 = {}^5/_{66}$, $B_6 = {}^{691}/_{2730}$, $B_7 = {}^7/_{6}$, etc. It will be observed that the first term of the second member is the same as formula (1) above.

A formula was given in ENGINEERING NEWS, Jan. 18, 1894, by W. F. Durand, without demonstration. It is as follows:

$$\int_a^b f(x)\,dx = h(0.4y_1 + 1.1y_2 + y_3 + y_4 + \ldots 1.1y_n + 0.4y_{n+1}) \quad (9)$$

NUMERICAL COMPARISON OF DIFFERENT FORMULAS

Below are a number of functions which were tested by some of the methods given above. The true value of the integral is given with the function. The values found by the several approximation formulas are tabulated on the opposite page.

(a) $\int_0^{1.2} x\tan^{-1}x\,dx = \frac{1+x^2}{2}\tan^{-1}x - \frac{1}{2}x = 0.468790638$

(b) $\int_1^{13} \log x\,dx = x(\log x - 1) = 9.2697202$

(c) $\int_0^{12}\frac{dx}{\sqrt{x^2-6x+13}} = \log(x-3+\sqrt{x^2-6x+13}) = 3.4041107$

(d) $\int_0^{12}\frac{dx}{e^x+e^{-x}} = \tan^{-1}e^x = 0.7853919$

(e) $\int_{12}^{24}\frac{dx}{x} = \log x = 0.693147181$

(f) $\int_1^{13} x^2\log x\,dx = \frac{x^3}{3}(\log x - \frac{1}{3}) = 709.810676$

(g) $\int_0^{0.12}\frac{dx}{\sqrt{1-3x-x^2}} = \sin^{-1}\frac{3+2x}{\sqrt{13}} = 0.1338071$

(h) $\int_3^{15}\frac{x\,dx}{(1-x)^3} = \frac{1}{2(1-x)^2} - \frac{1}{1-x} = 0.5510205$

(k) $\int_0^{1.2} x\sin x\,dx = \sin x - x\cos x = 0.4972116$

(l) $\int_0^{60°}\sin x\,dx = -\cos x = 0.500000$

(m) $\int_0^{12}\frac{x^3\,dx}{x^2+7x+12} = \frac{1}{2}x^2 - 7x + 64\log(x+4) - 27\log(x+3) = 33.26801696$

RESULTS OF NUMERICAL COMPARISON—It will be observed that formula (9) is considerably more accurate than (1) and scarcely more laborious, and that formula (5) is generally more accurate than any of the other Cotes formulas, although but little more trouble to apply. Formula (8) was applied in only one case; in some

cases the series converges very slowly and in others the successive differential coefficients are quite complicated.

If the function is unknown and the ordinates are not equidistant, being determined by observation or experiment, the integral can be determined approximately by passing parabolas through the various points by means of formula (6) and calculating their areas separately. This method is rather laborious, but is generally much more accurate than passing a polygon through the points.

A Committee of Engineers Recommends Amendments to the New York Constitution

A committee of engineers, representing four national engineering societies and two engineering societies of New York City, has formulated suggestions for the amendment of the Constitution of New York and submitted them on Apr. 20 to the members of the Constitutional Convention, now in session. The suggestions are as follows:

PRINCIPLES TO BE OBSERVED IN AMENDING THE CONSTITUTION OF NEW YORK STATE

The Constitution should insure:

a. A short ballot, making possible close scrutiny of the qualifications of all candidates and concentrated responsibility of elected officers.

b. Tenure of office for all elected officials, for heads of departments, and for bureau heads, of sufficient duration to attract competent men and to permit them to become increasingly efficient in the discharge of their duties.

c. A continuing policy in the organization and control of all departments, so that appropriations may be spent most economically and work carried on most efficiently.

d. Selection of heads of departments by appointment instead of election by popular vote.

e. Ample opportunity for the proper development of natural resources.

f. Recognition of the value of technical advice through the inclusion of professional engineers in the membership of departments or courts where such advice is essential to the proper conduct of the work or adjudication of the matters involved.

RECOMMENDATIONS

1. The elective office of the State Engineer and Surveyor should be abolished, and the duties should be transferred to the Department of Engineering and Public Works hereinafter proposed.

2. A Department of Engineering and Public Works should be created, to be headed by three commissioners appointed by the Governor, each to have a twelve-year term of office so arranged that a vacancy will be created every four years immediately after the inauguration of a new Governor. Commissioners should be eligible for reappointment. At least one commissioner should be a professional engineer in good standing in his profession, and each should have had experience that would fit him for the duties of the office. At least one and not more than two commissioners should be residents of New York City.

This department should have charge of public lands and boundary surveys; of buildings, parks, highways, canals and other public works, including design, construction, maintenance, and operation; and of the conservation and development of state resources

This department should be divided into suitable bureaus. Each bureau charged with responsibility for engineering work should be headed by a chief engineer selected by the commissioners with sole regard to his peculiar fitness for the duties of the bureau.

3. A Department of Public Utilities should be created, to be headed by five commissioners appointed by the Governor, each to have a ten-year term of office so arranged that a vacancy will be created every two years. Commissioners should be eligible for reappointment. At least two commissioners should be professional engineers in good standing in the profession. Each appointee should have had experience in connection with public utilities which would fit him for the duties of the office. At least two and not more than three commissioners should be residents of New York City.

This department should regulate and supervise all common carriers, all water-supply, irrigation, drainage, gas, power, lighting, heating, intelligence-transmitting and other public-utility corporations operating within the limits of New York State, including similar activities on the part of any other state department or political subdivision of the state.

This department should be divided into such bureaus as may be essential. Each engineering bureau should be administered by a chief engineer selected with sole regard to his peculiar fitness for the office, and he should have power, subject to the approval of the commissioners, to select and appoint such division engineers as are essential to the proper conduct of his office.

4. In case provision be made in the Constitution for the creation of one or more departments or commissions charged with responsibility for regulating, supervising, and inspecting buildings and the equipment thereof, trades, mines, industries or labor, each such department or commission should include in its membership at least one professional engineer in good standing in his profession. Commissioners should be appointed by the Governor. Each appointee should have had experience and should possess qualifications fitting him to perform the duties essential to the department or commission.

5. In case provision be made in the Constitution for the creation of a court or board of claims charged with responsibility for investigating claims against or on behalf of the state, one-third of the membership of such court or board should be made up of professional engineers in good standing in the profession, each to have practiced professional engineering for at least ten years and for at least five years to have had responsible charge of important engineering work either as to design or execution.

6. Removal by the Governor of any commissioner should be made only after the filing of charges and after affording the accused an opportunity to be heard in the matter, provided, however, that at any time within the first six months after making an appointment the Governor may exercise the power of summary removal. A successor to a commissioner who has been removed should be appointed to fill the unexpired term. Vacancies caused by removal or otherwise should be filled under conditions similar to those governing original appointment.

7. There should be no direct or implied prohibition against legislation which would permit the reference by a court of technical matters made the subject of, or incidental to litigation, to a referee expert in such technical matters, for the purpose of securing a determination concerning the facts, or which will prevent the court from selecting independent expert witnesses or advisers in matters of this character.

8. In order to make possible the reasonable development of state resources, the present constitutional prohibition against the use or sale of land and cutting of trees within the limits of the Forest preserve should be removed in so far as such use or sale of land or cutting of trees is essential to such development (Article VII, Section 7), and similarly to permit the development of other natural resources by private enterprise, provision should be made for the condemnation of private property necessary to the construction and operation of works for irrigation, drainage, sanitation, water supply, agriculture, mining, forestry, or power development, through the declaration of such project as for public use, subject, however, to the superior right of the state or of a subdivision thereof to condemn the same property or a portion thereof for state or municipal purposes (Article I, Section 7).

Committee of Engineers:

ARTHUR S. TUTTLE HENRY W. HODGE ALFRED D. FLINN	for American Society of Civil Engineers
GANO DUNN RALPH D. MERSHON WILLIAM McCLELLAN	for American Institute of Electrical Engineers
ARTHUR M. GREENE, JR. CHARLES WHITING BAKER E. GYBBON SPILSBURY	from American Society of Mechanical Engineers
RALPH D. MERSHON CHARLES W. LEAVITT, JR. ALTEN S. MILLER	for American Institute of Consulting Engineers
ALFRED D. FLINN GEORGE W. TILLSON ERNEST P. GOODRICH	for Municipal Engineers of The City of New York
NELSON P. LEWIS WILLIAM W. BRUSH JACOB S. LANGTHORN	for Brooklyn Engineers' Club

ARTHUR S. TUTTLE, Chairman,
CALVIN W. RICE, Secretary,
E. J. MEHREN, Assistant Secretary.

A committee of the American Institute of Mining Engineers, consisting of W. L. Saunders, Benjamin B. Lawrence, and J. Parke Channing, collaborated in the preparation of the "Principles" and "Recommendations," and, individually, the members of this committee approved them. Pending consideration by the Governors of the Institute, the committee was unable to sign officially.

The Sidewalk Problem; Its Solution in Pawtucket, Rhode Island

One of the most troublesome of a city's little engineering problems is the construction of sidewalks. Some cities make sidewalks part of the general street improvement, the property owners being assessed for the sidewalk as well as the pavement. Other cities leave the property owner to construct his own walk, or the option of doing it, with certain limitations. Few cities have established standards which are uniform for all parts of the city.

There are many good reasons why the construction of sidewalks should be wholly within the jurisdiction of the city engineering department. The sidewalk is just as much a part of the public highway as is the street pavement. Sidewalks should be uniform in character, at least in the same district or locality. To build a good sidewalk requires specifications and engineering supervision. In many cities the street-boundary monuments are placed in the sidewalk area, and it is essential that these should not be disturbed by unauthorized persons in the construction of sidewalks or in sidewalk repairing.

Unless the city has entire supervision of construction, it is seldom possible to build the sidewalks of a whole block or street simultaneously, and therefore isolated portions must be built at different times, under different conditions, and very likely at different costs for exactly the same work. Then the city must have a fixed price and make up deficits out of a general fund or be charged with unfairness.

All these difficulties have been met by the city of Pawtucket, R. I., and a solution has been found which answers admirably. The only criticism is that the walks laid under this scheme are widely separated and do not form a continuous sidewalk of any material length, but the plan is the best possible until the city receives legislative authority to proceed as in the case of street pavements when a majority of abutters petition. The work is done under the ordinance adopted in May, 1913, which reads:

Section 1—The board of aldermen is hereby authorized in its discretion, upon petition of abutters on any public highway of the city, to make concrete, cement or granolithic sidewalks in front of such abutting estates, said abutters to pay one-half of the cost of said walk, and the work to be done under the direction of the commissioner of public works.

Sec. 2—The board of aldermen shall make all necessary rules and regulations for the making of such walks and for the payment of the cost incurred.

Sec. 3—The city council shall not appropriate more than $5000 in any one year for carrying out the provisions hereof.

Some of the rules for the construction of concrete sidewalks drawn by the City Engineer, George A. Carpenter, are:

1. All sidewalks laid under the provisions of this ordinance shall be constructed of hydraulic cement concrete.

2. Applications for the construction of such sidewalks shall be made upon blanks furnished for that purpose.

. . . . . .

5. No such sidewalk shall be constructed upon any unaccepted street, and only upon those accepted streets where curbing is set in front of the premises where the sidewalk is desired.

6. Applications for the construction of sidewalks in the first building district as laid out by the city ordinances shall be for the full width of 8 ft. No walks are to be less than 5 ft. wide.

7. The sidewalks shall be built under the direction of the commissioner of public works and under the supervision of an inspector from the office of the city engineer. All work must be done according to specifications approved and grades furnished by the city engineer.

8. The water necessary for the construction of such sidewalks shall be furnished by the owner of the premises in front of which the sidewalk is to be laid, but no charge for such water shall be made by the owner furnishing the water for the construction of sidewalk in any way to offset the amount payable to the contractor by said owner.

9. Out of any appropriation made for carrying out the purposes of this ordinance the city shall pay to the contractor one-half the expense agreed upon for the construction of any such sidewalk, in the manner provided for paying the current expenses of the city, and the remaining one-half of the expense, after approval of the commissioner of public works, shall be collected by the contractor from the owner of the property.

10. No sidewalk shall be laid before Apr. 15 of any calendar year, or until all frost is out of the ground, and no such sidewalk shall be laid in freezing weather.

11. Previous to Apr. 15 in each calendar year, the commissioner of public works shall advertise for bids for the construction of any and all hydraulic cement concrete sidewalks that the city may decide to lay under the terms of the ordinance during the current fiscal year.

SPECIFICATIONS—An abstract of the specifications for these standard cement concrete sidewalks is as follows:

The work to be done consists of furnishing all the materials and labor and the laying of hydraulic cement concrete sidewalks at times and places directed by the commissioner of public works, and subject to his acceptance and rejection.

GRADING AND EXCAVATION—The ground to be occupied by the sidewalk shall be excavated to a subgrade which, after being compacted, shall be 10 in. below the finished surface of the walk. The subgrade shall be dressed to nearly a plane surface sloping downward toward the curb ¼ in. in 1 ft. horizontal. The completed subgrade shall project 4 in. in excavation and 18 in. in embankment on each side beyond the edges of the completed walk. After grading the surface shall be compacted by rolling or ramming.

DRAINAGE COURSE—Upon the subgrade prepared as specified a drainage course composed of broken stone or gravel 6 in. in thickness shall be laid. Broken stone for this purpose may be of any desirable stone crushed to such size that all will pass through a 2-in. screen. Crusher-run material may be used unless it contains an excessive quantity of fine material. Gravel for the purpose may be any sound, durable gravel, all of which will pass a 2-in. screen and be retained on a ¼-in. screen.

After grading, the drainage course shall be thoroughly compacted by ramming or rolling and shall be kept wet while being thus compacted. Its surface shall be brought to a plane parallel to and 4 in. below the designed surface, after which inequalities may be leveled up with screenings or small gravel.

The bottom of the drainage course may be ordered connected with the sewer by suitable drain-pipe connections if considered necessary by the engineer. If such connections are required they shall be paid for as extra work upon the valuation of the engineer as specified in the contract.

CONCRETE—The concrete is to be made of portland cement, sand and broken stone. The foundation course 3 in. thick is to be mixed 1 : 2½ : 5. The surface or wearing course is to be mixed 1:1:1. Stone shall be of trap or granite and shall pass ½-in. screen opening. The surface or wearing course shall be put on before the foundation course has begun to set. Coloring is to be used if desired.

EXPANSION JOINTS—After the laying of both courses is completed, the walk shall be cut into rectangular blocks, not exceeding 25 sq.ft. in area, by expansion joints at right angles to axis of the sidewalk. The joints shall be located by a line on the surface of the sidewalk and a straight-edge cutting tool ¼-in. thick shall be used to cut entirely through both courses of concrete, accurately along the line marked out, entirely across the walk, after which a T-shaped trowel or other tool shall be used to smooth and compact the cut surfaces for a depth of 1 in. and to round off the corners to a radius of ¼ in.

CONTRACT LETTING—The plan of letting the sidewalk work of the year at a unit price assures a uniform assessment to every property owner, however isolated or small the piece of work may be. The price in 1914 was $1.65 per sq.yd. The contractor is paid each month for all the work completed in the previous month.

News of the Engineering World

The Roosevelt Reservoir Filled

The reservoir created by the Roosevelt Dam across the Salt River in Arizona, one of the earliest and largest U. S. Reclamation Service projects, was filled to the dam crest for the first time on Apr. 14. The accompanying view shows the water going over the spillways. This dam was started in 1905 and formally opened on Mar. 18, 1911. It is 280 ft. high above bedrock, 1080 ft. long (including spillways) and the reservoir has a capacity of about 1,300,000 acre-feet. A well-attended celebration, with speeches by government officials, marked the overflow of the crestline.

WATER COMING OVER ROOSEVELT DAM ON APRIL 14

⁂

Water Company Purchase Defeated at San Francisco

Although a majority of 6457 votes (39,975 for, to 33,518 against) was cast in favor of the purchase of the water-works of the Spring Valley Water Co. by the electors of San Francisco on Apr. 20, the proposition was not carried because a two-thirds majority is required. We are informed that the 38-year struggle for municipal ownership of water-works by the city of San Francisco will be continued by asking the state Railroad Commission to appraise the plant and then by making another appeal to the voters.

In 1913, after negotiations begun in 1877 and renewed from time to time, but always rejected by one side or the other, the city decided to institute condemnation proceedings for the acquirement of the plant of the company. Engineers employed by the city arrived at a valuation of $34,796,745, of which slightly under $14,000,000 was for physical structures, including stock and material on hand, and the balance for real estate, riparian and other water rights, and going-concern value, the latter figure being $2,500,000. This estimate did not include the valuation of 80,000 service connections which the city contended belonged to it or to the consumers. Engineers employed by the company to value its property estimated the land values at about the same as those placed by the city, but the reproduction valuation was set at $18,000,000, after allowing $4,000,000 for depreciation. In other words, there was a difference of $4,000,000 between the reproduction values set by the engineers for the city and those for the company. The representatives of the two parties agreed to a purchase price of $34,500,000 in order to save protracted court proceedings. The matter then went to popular vote, with the results already stated.

Had the election resulted in a statutory majority of votes, it was the intention of City Engineer M. M. O'Shaughnessy—under whose direction the valuation for the city was made—to immediately rush to completion the Calaveras dam (see ENGINEERING NEWS, Oct. 1, 1914) and also to commence at once the laying of additional distributing mains to supply outlying districts of the city.

Toronto Refuse Destructor

A contract for a 180-ton high-temperature refuse destructor, but without provision for heat utilization, has been awarded by the city of Toronto to the Canadian Griscom-Russell Co., of Montreal, for $49,200. The flues, air heaters and chimney will be of special design to withstand the high temperatures of the waste gases. The destructor will consist of three four-cell units. These and the flues will be the only work included in the contract.

The city will erect the building, chimney and foundations. The collecting wagons will drive into the upper story of the building and discharge their contents into a long receiving bin. The refuse will be discharged from this bin into hydraulic-operated containers by means of a traveling crane and grab buckets. The containers can also be filled by hand, if desired. The clinker and ashes will be dumped into self-tipping clinker cars located in a dust-tight basement below the stoking floor.

The specifications call for a minimum destructor capacity of 180 tons of 2000 lb. each in 24 hr. to be burned without additional fuel, the refuse to contain not more than 940 lb. of water and not less than 460 lb. of combustible per ton. The bids on which this award was made were received on Feb. 17. Soon after, George B. Wilson, Street Commissioner, recommended that the award be made to the company named above, but the Council did not act upon the recommendation until Apr. 19. Irwin S. Osborn, Consulting Engineer to the Toronto Department of Street Cleaning, has been conducting studies of refuse collection and disposal for some time past. We understand that he will have charge of the erection of the plant on behalf of the city.

In our issue of Feb. 22, 1912, appeared an abstract of a report on refuse disposal at Toronto made by Hering & Gregory. The report recommended that in view of the low price of hydro-electric power in Toronto the city adopt garbage reduction rather than incineration. Instead of following this recommendation the city decided on incineration, but, as has already been stated, without any attempt at heat utilization.

Produce Market and Railway Terminal for Chicago

A central union produce market, with warehouse and retail buildings and with both railway and water transportation, is to be built at Chicago. This is to supersede the inadequate and congested facilities of the present produce-market district, which is distant from the several railway terminals, so that great loss of time and damage to perishable goods are involved in the teaming between the terminals and the markets.

The new site is on the south side of 39th St., extending from Ashland to Western Ave., and having the Chicago River at the rear. It will have about one mile of street front and an area of 100 acres. It is adjacent to the existing yards of the Chicago Junction Ry., a belt line which affords connection with all the trunk lines, so that produce trains may be run directly into the terminal. It is adjacent also to the stockyards and to the central manufacturing district, so that it will have ample switching facilities. There will be a dock, or slip, capable of accommodating large vessels and it is intended to operate a service of lighters connected with the steamship piers and other points on the river.

In the center of the plant will be an eight-story building, with the first two floors forming a railway freight station and the other floors for cold-storage warehousing. This will be flanked by tracks on both sides. Between the building and 39th St. will be a covered shipping space for wagons. On each side of this will be a group of three-story market buildings, leased in sections to numerous dealers. In addition there will be an auction building, a power house, an administration and office building, a garage with accommodation for 350 motor trucks, and a waterfront freight house for lighterage and steamer service.

The freight station will be specially for less-than-carload business, with inbound tracks on the upper floor and outbound tracks on the lower floor. For carload business there will be a yard with track space for about 350 cars, convenient for access and inspection by buyers. The auction building will also have indoor track space for about 100 cars. Covered driveways will extend from the buildings to the yards, so that motor trucks can handle goods under cover between the market space and the cars or vessels. Refrigerated motor trucks are to be operated also to serve the outlying markets.

The buildings will be of reinforced concrete, equipped with sprinklers, light, heat, plumbing, and electric elevators. The market and terminal will be built by the Produce Terminal Co.; President, J. A. Spoor; Vice-President, Arthur G. Leonard (both of the Union Stock Yards & Transit Co.); Secretary, Anderson Pace. The estimated cost of land and buildings is $20,000,000. Work has been commenced on the clearing and grading of the site.

Further Attacks on Engineers

Attacks upon an engineering commission by trustees of the Sanitary District of Chicago and members of the City Council because the commission's report on the water-power plant of the Chicago drainage canal was not to the trustees' liking were noted in ENGINEERING NEWS, Feb. 11. The Sanitary District trustees have now gone farther by deposing Lyman E. Cooley (chairman of the commission) from his position as consulting engineer for the District. From the published report of the meeting at which this step was taken it seems that they were moved to this action largely by the wide publicity given to the report and by the resolutions of the Western Society of Engineers protesting against such personal attacks being made upon engineers simply because their report did not present the opinions which had been anticipated.

This engineering commission (whose report was reviewed in ENGINEERING NEWS, Dec. 3, 1914) was appointed by the trustees of the Sanitary District. The trustees therefore are now in the position of having discharged their consulting engineer because he presumed to differ from them in a technical matter. Their idea seems to be that because the power plant is the property of the District it must of necessity be well designed and uptodate (though it was built a good many years ago), and that any criticism of the plant amounts to lèse majesté.

A Collision between an Interurban Car and an Oil-Tank Wagon in Chicago on Apr. 17 caused a violent explosion, followed by fire. The wagon contained 1500 gal. of oil.

Three Bridges Damaged—A new bridge was damaged by ice near Tony, Wis. The bridge, which was over the Flambeau

River and had not been accepted yet by the county, was 480 ft. long. The contract price was $10,492. A bridge failed under the weight of a motor truck loaded with curbstones, at Youngstown, Ohio, on Apr. 9. It was kept from falling to the bottom by a steel girder. A trestle burned on the Kansas City & Southern Ry. at Gentry, Ark. It was set on fire by a freight train and more than 330 ft. of trestle was burned.

Forest Fires in Pennsylvania and Massachusetts—Damage estimated at $125,000 has been caused by forest fires in Cumberland County, Penn. The entire state reserve of 20,000 acres near Pine Grove has been burned over and, according to press dispatches, a large icehouse and twenty cottages at Mount Laurel were destroyed on Apr. 20. Four hundred men under state officers were called out to fight the fire. A forest fire at Brimfield and Wales, Mass., on Apr. 20, burned over a considerable tract of wood and grass land. It was caused by a farmer burning over his rye field, the fire getting out of control.

Limon Breakwater Damaged Again—The second norther of the dry season swept Colon Harbor on Apr. 3, causing further damage to the trestle of the East Breakwater in Limon Bay. In the first norther, on Feb. 8-10, noted in "Engineering News" at the time, a 4200-ft. section of the trestle was washed out. Of the remainder of the trestle, 2100 ft. retained the decking. The second storm swept away the decking of all but 160 ft. of the 2100-ft. section, as well as 364 ft. of single-track trestle which had been built in the gap between the first relay station and the breakwater proper, and tore off about 300 ft. of decking at the outer end of the double-track trestle. At the present time the trestle remains undamaged from the shore to a point 1100 ft. out. The maximum wind velocity on Apr. 3 was 46 mi. per hr.

A Gas Explosion in the Valve Chamber of the sewage-treatment works of Ocean Grove, N. J., on Apr. 25, seriously burned three men of a party of visitors, one of whom died soon afterward. No structural damage was done. There was an open flow of sewage through the chamber and beneath a baffle wall into a septic tank. Both the chamber and the tank were underground. It is believed that illuminating gas brought in with the sewage had accumulated in the valve chamber and that it was ignited by a match struck to light a cigar by one of the three injured visitors just as he reached the floor of the chamber. At the time of the explosion the second visitor was halfway down the ladder leading to the floor of the chamber and the third visitor was just starting down. The last—Walter C. Bowen, engineer-assistant to Clyde Potts, 30 Church St., New York City—was thrown some distance from the manhole opening. The second man was blown part way out and died later of his injuries. The three men were rescued and the fire in their clothing was extinguished by Mr. Potts and other bystanders. Among the latter was Ethelbert Bacon, of Elmira, N. Y., another assistant to Mr. Potts. In carrying the man out from the bottom of the chamber Mr. Bacon was burned by the fire in the clothing of the injured man.

The Sixth Edison Medal will be presented to Dr. Alexander Graham Bell for his invention of the telephone at a meeting to be held in the Engineering Societies Building auditorium, New York City, on Tuesday evening, May 18. This will be one of the events in connection with the annual meeting of the American Institute of Electrical Engineers.

The Berlin Electricity Works were recently purchased by the city at a price of $32,000,000, or $92 per kilowatt of machine capacity, including storage batteries and converters. Until now this has been a private property paying 12 per cent. yearly dividends and returning about $1,750,000 per annum to the municipality. The franchise expired and a purchase clause was utilized. The local rate has been 9.5c. per kw.-hr. flat, and desire for lower industrial rates is reported as the reason for the purchase.

A Concrete Road just completed in Cook County, Ill., was formally christened by breaking a bottle of champagne upon it on Apr. 22. That date was appointed "Road Day" by a proclamation of Governor Dunne. A procession of 137 automobiles went out from Chicago to the village of Niles, and at a point where a new concrete road was laid last winter, the President of the Cook County Road Board removed the last shovelful of earth. Upon the space thus cleared a young lady in the party broke a bottle of champagne and christened the road Milwaukee Ave. In view of the name chosen, a different christening liquid might have been appropriate.

Overland Wireless Telephony between Scranton, Penn., and Binghamton, N. Y., a distance of 63 mi., has been developed by L. B. Foley, Superintendent of Telegraphs of the Delaware, Lackawanna & Western R.R. For some time the company has maintained wireless-telegraph communication between Hoboken, N. J., Scranton, Binghamton and Buffalo, N. Y., and between these stations and moving express trains (as noted in "Engineering News," Jan. 7, 1915, p. 45): This service has been relied on in emergencies (storms) to maintain the train dispatching. The use of radio-telephony as well as telegraphy is a part of the development of this auxiliary service; it is desired thus to communicate over a distance of 50 mi. from a fixed station to a train and over 150 mi. between fixed stations.

A Portrait of the Late Alfred Noble was unveiled with appropriate ceremonies at the Engineers' Club, New York City, on the evening of Thursday, Apr. 22. Mr. Noble's death occurred a year ago, on Apr. 19, 1914, and the unveiling of the portrait was made by the club the occasion of a special meeting to honor Mr. Noble's memory. Stevenson Taylor, president of the club paid high tribute to Mr. Noble's qualities as a man. J. Waldo Smith spoke of Mr. Noble's ability as a civil engineer. Prof. F. R. Hutton described Mr. Noble's services to the profession as an officer of the American Society of Mechanical Engineers and a member of the joint committee which planned the buildings of the United Engineering Societies and the Engineers' Club. H. F. de Puy related experiences with Mr. Noble as a camp-mate during summer vacations on the north shore of Lake Superior. Two years ago while in camp there with Mr. Noble, far from all routes of travel, they were surprised by the appearance of a Government lighthouse tender. The Secretary of the Navy had sent Admiral Stanford, chief of the Bureau of Yards and Docks, to find Mr. Noble and secure his services to go to Pearl Harbor, Hawaii, and advise the Government how the difficult problem presented by the failure of the Pearl Harbor drydock might be solved.

The Steam Yacht "Isis," one of the best known of the larger pleasure vessels of American registry, has been purchased by the Federal government for the use of the U. S. Coast and Geodetic Survey. She will be put in immediate service on the Atlantic Coast, replacing the 50-year-old "Endeavor," which has been condemned. The "Isis" is considered by yachtsmen one of the finest and most complete vessels of her type ever built in this country. She has twin screws, which is a particularly desirable quality in a surveying vessel. Her length over all is about 200 ft.; beam, 25 ft. and draft, 12 ft. She has twin triple-expansion engines of 2000 hp., and her cruising speed on natural draft is 12 knots. The price of the vessel was approximately $60,000, less than one-third of the original cost. This leaves enough money out of the $289,000 appropriated for new vessels to obtain one of required size and type for the important charting operations around Alaska. It is expected to have the interior arrangements of the "Isis" altered to accommodate a crew of 41 men and 9 officers, and thus make her available for replacing the surveying vessel "Bache" on offshore work. This, in turn, will make it possible to use the "Bache" in place of the "Endeavor" on inshore work. As the "Bache" is really not fit for offshore duty, but is fit for the inshore work formerly done by the "Endeavor," this means that the Department of Commerce, by the purchase of the "Isis," is in reality providing two suitable surveying vessels for the price of one.

The Brick Wall of a Fire-Gutted Building at Birmingham, Ala., collapsed into two adjoining buildings on Apr. 21, burying in the ruins a number of employees and shoppers. Up to Apr. 23 eight bodies and 12 injured had been removed from the ruins. In December, 1914, a fire occurred in a five-story building, 50x140 ft., occupied as a dry-goods, millinery and notions store. The débris was cleaned out, and such portions of the walls as were considered unsafe were torn down. About one-third of the west wall above the third floor was taken down, but the east wall and practically all of the front and rear walls were left standing. The architect that examined these walls decided that the east wall was sufficiently stable to allow its use in reconstructing the building. About 5 p.m., Apr. 21, during a high wind from the west, the two upper stories of the east wall fell eastward. Apparently at the same time the third-story height of this wall was kicked westward into the burned building. The two upper stories fell onto a three-story building 25x140 ft., occupied as a retail shoe store, and on a two-story building just to the east of the three-story building, also on a lot 25x140 ft., occupied as a coffee and tea store. The east wall was not a party wall, but in falling it carried with it the upper story of the west wall of the three-story building. The roof and all floors of each of these stores were carried down to the ground floor. As this location was in the heart of the retail district, there were many shoppers, especially in the shoe store. Conditions were somewhat complicated by the fact that fire broke out in the shoe store immediately after the disaster. Escaping gas from a broken pipe evidently added to the flames until the gas was cut off. The fire was quickly extinguished, although several of the bodies removed were very much burned.

ENGINEERING SCHOOLS

STEVENS INSTITUTE OF TECHNOLOGY—The alumni endowment committee, led by Walter Kidde, chairman (Consulting Engineer, New York City), and Newcomb Carleton, treasurer (President, Western Union Telegraph Co., New York City), is making vigorous efforts to complete before May 1 the Institute's debt-retirement and new-endowment funds. The Institute has recently been carrying debts of $375,000, caused in considerable part by the acquisition of the Stevens Point property overlooking the Hudson at Hoboken, and has a conditional gift of $50,000 which must be met with $325,000 cash May 1. The alumni committee has gone beyond this, however, and is attempting to complete an additional $500,000 by that date to meet the offer of an equal sum from the Carnegie and Rockefeller Foundations. This extra million is to be divided between new equipment and endowment. Of the unconditional $825,000, about $40,000 remains to be raised during the last week of April. Strenuous efforts are now being made to secure this amount.

PERSONALS

Mr. Wilbert R. Rosche has opened an office, as a consulting civil and mechanical engineer, at 329 Thatcher Bldg., Pueblo, Colo.

Mr. P. F. McManus has been appointed General Superintendent of the Elgin, Joliet & Eastern Ry., with headquarters at Joliet, Ill.

Mr. B. J. Schwendt has been appointed Superintendent of Telegraph and Signals of the Toledo & Ohio Central and Zanesville & Western Rys., with headquarters at Columbus, Ohio.

Dr. J. W. S. McCullough, Ontario Provincial Health Officer, has been appointed Assistant Sanitary Expert of the International Joint Commission on Waterways of the United States and Canada.

Mr. E. E. Schuets, formerly County Engineer of Merrion County, Missouri, has been appointed Assistant Highway Commissioner of Missouri, to fill the vacancy created by the resignation of Col. W. S. Hawkins.

Mr. Frank H. Villie, City Engineer of South Bethlehem, Penn., has resigned in order to resume his private practice as a civil and consulting engineer, with offices in the E. P. Wilbur Trust Co. Bldg., South Bethlehem.

Mr. B. G. Covington, Chief Engineer of the St. Francis Levee Board of Arkansas, will retire from office May 11 and give his attention to the cultivation of his 1700-acre farm at Ripley, Tenn. Mr. Covington was appointed an Inspector on the Board in 1901. In 1904 he was made Assistant Chief Engineer under Mr. Harry N. Pharr, and in 1907 he succeeded the latter as Chief Engineer.

Mr. H. H. Vaughan, M. Am. Soc. M. E., Assistant to Vice-President, Canadian Pacific Ry., in charge of the Locomotive and Car Department, has resigned to take charge of a manufacturing enterprise. He will be succeeded by Mr. William E. Woodhouse, Superintendent of Motive Power and Car Department of the Eastern Lines of the System, with headquarters in Montreal. Mr. D. T. Main, who has been in charge of the Mechanical Department at Toronto, will succeed Mr. Woodhouse.

Mr. William J. Orchard has resigned as Assistant Sanitary Engineer of the New Jersey State Board of Health to become associated with Wallace & Tiernan Co., Inc., manufacturers of chlorine control apparatus and sanitary specialties, 136 Liberty St., New York City. Mr. Orchard is a graduate of the Massachusetts Institute of Technology, and previous to his connection with the New Jersey State Board of Health had been in the Engineering Departments of the Massachusetts State Board of Health and of the Metropolitan Water and Sewerage Board of Massachusetts.

Mr. Frank L. Averill, M. Am. Soc. C. E., a member of the firm of Averill & Adams, Structural Engineers, Washington, D. C., has been appointed by President Wilson to be Superintendent of the Congressional Library, at a salary of $3000 per year, to succeed the late Bernard R. Green. Mr. Averill has had a varied experience as an engineer. During the early years of his career he engaged in railroad work, later entering the office of the Supervising Architect of the Treasury, where he was subsequently made Chief Structural Engineer. Since leaving the Treasury Department, he has done considerable engineering work in Washington and vicinity, notably the design of the foundation and other structural features of the Senate and House office buildings, and much work on the Capital Building.

OBITUARY

Herman Long, general contractor, of Kansas City, Mo., died recently at his home in that city, where he had been in business for 40 years.

David James Mackey, at one time President of the Louisville, Evansville & St. Louis R.R., died at Evansville, Ind., his birthplace, Apr. 9. He was 82 years of age.

Warren Archer Conover, who was head of the firm of W. A. & F. E. Conover, died at his home in Brooklyn, N. Y., Apr. 20, in his 68th year. Mr. Conover erected the Postal Telegraph Building and the New York Casino.

Edgar H. Mumford, M. Am. Soc. M. E., Vice-President and General Manager of the Mumford Molding Machine Co., of Chicago, died at his home in Plainfield, N. J., Apr. 18, in his 52d year. He is survived by a widow and four children.

Neil Mathison, Bridge Superintendent of the Northern Pacific Ry. for the past 20 years, and a resident of Duluth, died suddenly from apoplexy at Cromwell, Minn., Apr. 19, age 58 years. Mr. Mathison is survived by a widow and two sons.

John A. Culverwell, Assoc. Am. Inst. E. E., hydraulic and electrical engineer of Port Hope, Ont., died in Toronto, Apr. 21, in his 49th year, after a short illness. About 15 years ago he became associated with the development of the Trent Valley Canal in Eastern Ontario, and promoted several electrical projects dependent upon this source for power.

Alexander B. Andrews, First Vice-President of the Southern Ry., died at his home in Raleigh, N. C., Apr. 17, in his 75th year. Colonel Andrews was born in Franklin County, North Carolina, in 1841. He served in the Confederate Army during the Civil War, after which he entered the service of the old Raleigh and Gaston Ry. Co., now the Seaboard Air Line, as Superintendent. In 1894 Colonel Andrews was made Second Vice-President of the Southern Ry., and in 1895 First Vice-President.

S. Percy Hooker, of Le Roy, N. Y., who was a member of the New York State Highway Commission appointed by Gov. Hughes, died in New York, Apr. 24, in his 55th year. Mr. Hooker was manager of some mining enterprises in Arizona in the '90s. He was elected to the New York Senate in 1906 and was appointed Highway Commissioner in 1909. After being legislated out of office in Gov. Dix's administration, he was appointed State Highway Commissioner of New Hampshire by Gov. Bass.

ENGINEERING SOCIETIES

COMING MEETINGS

AIR BRAKE ASSOCIATION.
May 4-7. Convention at Chicago. Secy., F. M. Nelis, 53 State St., Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.
May 10-14. Annual meeting in Cincinnati. Secy., J. M. Diven, 47 State St., Troy, N. Y.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 11-13. Annual meeting at Hotel Astor, New York City. Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass.

CONFERENCE OF BUILDING INSPECTORS.
May 14. Meeting in New York City. Secy., Sidney J. Williams, Madison, Wis.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 17-20. Annual meeting at Chicago. Secy., C. G. Hall, 922 McCormick Bldg., Chicago.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 19. Annual convention at Galveston, Tex. Secy., H. S. Cooper, Dallas, Tex.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.
May 20-21. Spring meeting at Atlantic City, at Hotel Marlborough-Blenheim. Secy., Charles E. Hildreth, Worcester, Mass.

MASTER BOILER MAKERS' ASSOCIATION.
May 25-28. Annual meeting in Chicago. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
June 3-4. Annual convention at Bellevue-Stratford, Philadelphia, Penn. Secy., F. D. Mitchell, 1510 Woolworth Bldg., New York City.

NATIONAL DISTRICT HEATING ASSOCIATION.
June 1-3. Annual convention at Hotel Sherman, Chicago. Secy., B. L. Gaskill.

NATIONAL CONFERENCE ON CITY PLANNING.
June 7-9. National Conference in Detroit, Mich. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 9-11. Annual convention in Atlantic City. Secy., Jos. M. Taylor, Karpen Bldg., Chicago.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual convention in Atlantic City. Secy., Jos. M. Taylor, Karpen Bldg., Chicago.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
June 17-18. Semi-annual meeting at Toledo. Secy., Frank E. Sanborn, Ohio State University, Columbus.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 22-25. Annual meeting at Iowa State College, Ames, Iowa. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 22-25. Summer meeting at Buffalo, N. Y. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 22-26. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn

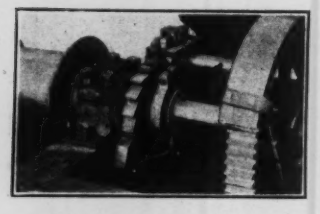
National Electric Light Association—At the annual convention, to be held in San Francisco, June 8-11, the following papers will be presented: "Features of the Lighting of the Panama-Pacific Exposition," W. D'A. Ryan; "Some Opportunities of Public Utility Accountants," L. H. Reynolds (Auditor, California R.R. Commission); "Practice in High-Head Hydraulic Plants," J. P. Jollyman; "Governor Effort Analysis," E. D. Searing; "Overhead Line Construction on the Coast," J. C. Martin; "Analysis of Costs by an Electricity Supply Company for Rate-Making Purposes," A. D. Spencer and R. W. Symes; "The Commercial Application of Resistance Furnaces," C. W. Bartlett; "A Stassano Furnace Installation at Redondo, Calif.," W. W. McKnight; "Electric Furnace Power Loads," F. T. Snyder; "Charges for Electric Welding Service," C. K. Nichols; "Timber Preservation," R. A. Griffin; "Public Service Commission Relationships," John H. Roemer (ex-member Wisconsin Railroad Commission); "The Electric Vehicle and the Central Station," J. F. Gilchrist and A. J. Marshall.

Staten Island Association of Arts and Sciences—On Apr. 16 a meeting was held under the auspices of the sections of Engineering, Architecture and Applied Professions. L. L. Tribus delivered an address, "Travel Notes on Water-Supply, Ancient and Modern." The secretary is Arthur Hollick, New Brighton,

Appliances and Materials

Safety Lock for Hoists

The safety catch shown in the accompanying illustration has been developed by the Dobbie Foundry & Machine Co., of Niagara Falls, N. Y., to prevent motor-driven contractors' hoists from backing up if current should fail. The device was designed particularly for the "subway" hoists used in New York City (described in these columns, Mar. 4, 1915). A heavy ratchet is fastened on the drum shaft and the pawl for it is pushed into or out of engagement by a rod running to a friction band on the ratchet hub.



HOIST SAFETY LOCK

* * *

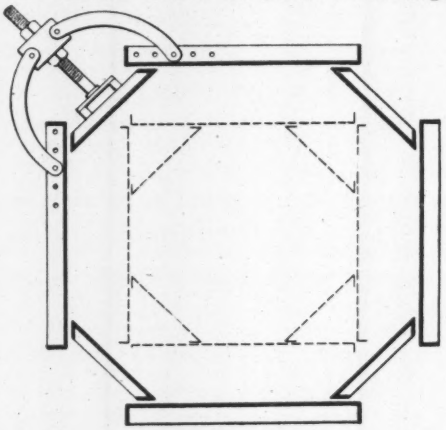
Balanced Window Sash

A new metal-window construction for factories and industrial buildings has the upper and lower sash frames (sliding in guides) connected and balanced by a device which dispenses with chains, pulleys and counterweights. Fixed on each side of the window frame is a ball-bearing pinion which engages with racks on the two sash frames, so that as one sash is pushed up it revolves the pinions and causes the other sash to be lowered. Brass guides exclude dust and rain. These windows are manufactured by the American Window & Door Co., of Chicago.

* * *

Adjustable Column Form

A new adjustable form for concrete columns of octagonal section is shown in the accompanying sketch. It has four sides of constant width formed by plates which can be moved inward and outward. The width of the other four sides of the column varies. The plates of the larger sides



ADJUSTABLE STEEL COLUMN FORM

are carried by jointed yokes whose ends are secured by pins to holes in the form braces. The plates of the "corners" are attached to threaded rods which pass through the yoke and are adjusted by means of nuts. These corner plates are adjustable vertically also, to allow of connections to beams or girders. The column diameter can be increased 50% beyond the minimum. This construction form is being handled by the C. S. Concrete Form Co., 716 Dwight Bldg., Kansas City, Mo.

* * *

Large Land-Leveler

For improving farmlands and for general land-leveling work the large scraper shown in the accompanying view has been developed by the Schmeiser Manufacturing Co., of Davis, Calif. There are three sizes—(1) the "Giant," with an 11-ft.

SCHMEISER LAND-LEVELER

bucket which takes from 4 to 7 yd. of soil at a time, (2) the "Junior Giant," with an 8-ft. bucket which moves 2 to 4 yd., and (3) the "Midget," which has an 8-ft. bucket and holds 1½ yd. The largest size is drawn by a traction engine and requires but two men. The "Midget" can be used with a tractor or may be drawn by ten horses.

* * *

Portable Gasoline-Engine Air Compressor

A new portable gasoline air compressor has just been placed on the market by Cris. D. Schramm & Son, Philadelphia, Penn. This is of larger capacity than the unit previously manufactured by this concern (noted in our issue of Jan. 21, p. 126). The new machine is 5 ft. 10 in. by 3 ft. 2 in. high and is mounted on a four-wheeled frame, the front wheels of which are 10 in. in diameter and the rear 14 in. The gasoline engine has 5-in. bore and 6-in. stroke; the compressor, 4-in. bore and 6-in. stroke. The air-storage tank is 16 in. in diameter by 30 in. long. The gasoline tank has capacity for 6 gal.